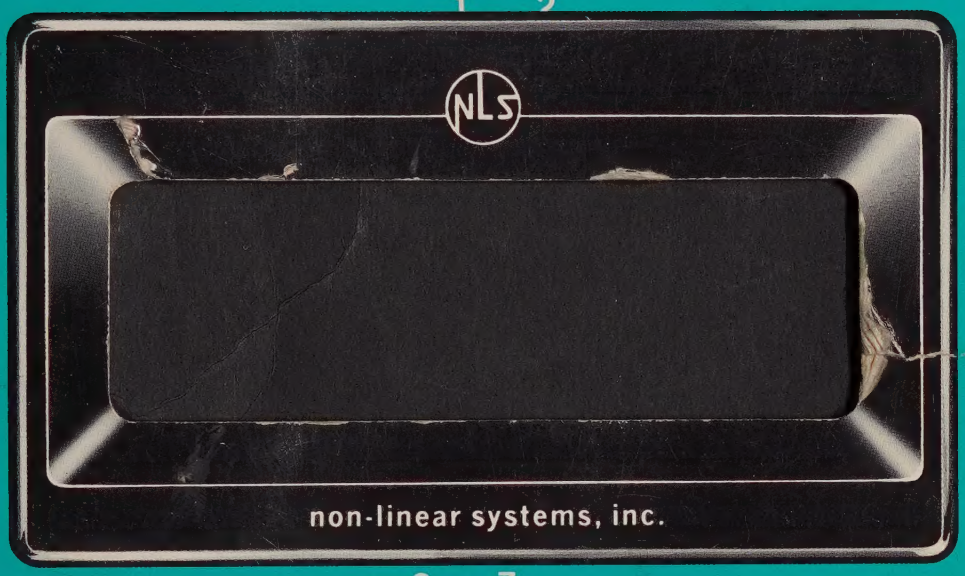


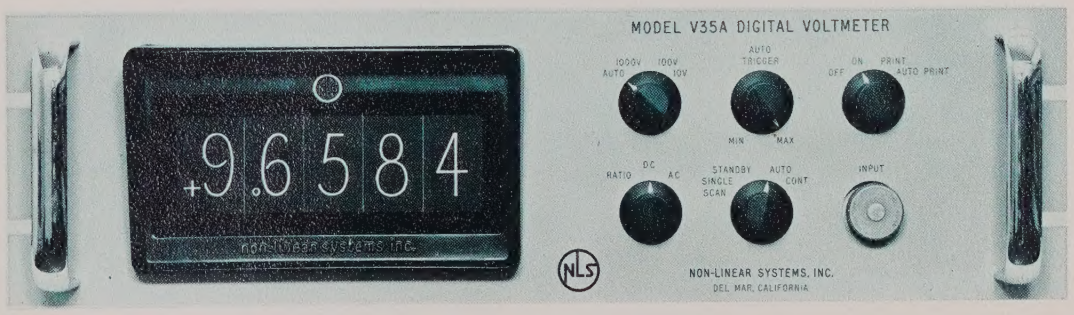
non | linear
systems, inc.

DEL MAR, CALIFORNIA

Instruction Manual

V-34A and V-35A

Digital Voltmeters



This manual is for instrument Serial No._____

Non-Linear Systems, Inc.
Del Mar, California

V34A/V35A

First Printing 500 May 1961

Second Printing 500 Aug. 1961

Third Printing 300 Jan. 1962

Fourth Printing 200 July 1962

Entire contents copyright, 1961. *No part of this book may be reproduced without written permission from Non-Linear Systems, Inc., Del Mar, Calif.*

TABLE OF CONTENTS

PAGE			SECTION
1	Application . . . Features . . . General Description . . . Accuracy . . . Ranges	INTRODUCTION AND SPECIFICATIONS	I
5	Preparing the instrument . . . Grounding . . . Connecting to Power Source . . . Using the Controls	INSTALLATION AND OPERATION	II
11	Basic Settings . . . Ranging . . . Absolute Accuracy	CALIBRATION	III
13	Basic Theory . . . The Kelvin-Varley Divider . . . Scan and End-of-Scan Logic . . . Description of Plug-in-Boards	THEORY OF OPERATION	IV
35	Access . . . Test Equipment . . . Zener Supply . . . Trouble-shooting Chart	MAINTENANCE	V
49	The Spares & Service Kit . . . Listing by Unit Assembly . . . Spares Requirements . . . Circuit References	PARTS LIST	VI
59	Warranty Shipping Notice Short Form Catalog Sales & Service Representatives Schematics (See list on next page)	APPENDIX	VII

LIST OF SCHEMATICS

11420, Sht. 3	V34A Outline Drawing
11520, Sht. 3	V35A Outline Drawing
11400-700, Sht. 2	Decade Switch Assembly
11400-730, Sht. 2 – Chg. 1	Transfer Switch Assembly
11400-750, Sht. 2	Decade 5 Adapter
11420-050, Sht. 2 – Chg. 2	Zener Supply Assembly
11420-100, Sht. 2 – Chg. 5	Main Board Assembly
11520-100, Sht. 2 – Chg. 5	Main Board Assembly
11420-200, Sht. 2 – Chg. 1	"A" Board Assembly
11420-300, Sht. 2 – Chg. 2	"B" Board Assembly
11420-400, Sht. 2	"C" Board Assembly
11420-500, Sht. 2	"D" Board Assembly
11420-600, Sht. 2 – Chg. 2	Amplifier Board Assembly
11420-800, Sht. 2	4 Relay Board Assembly
11420-830, Sht. 2	2 Relay Board Assembly
11420-860, Sht. 2	Decimal Check Board Assembly
15004-125	Cable, External Reference
15004-126	Cable, Input
15057, Sht. 2 – Chg. 2	Remote Control

LIST OF ILLUSTRATIONS

PAGE		
5	2-1	Power Plug Pin Coding
6	2-2	Top: Signal Input Cable Bottom: External Reference Supply Cable
7	2-3A	External Reference Supply Connection . . . To Measure Positive and Negative Input Voltages
7	2-3B	External Reference Supply Connection . . . To Measure Input Voltages of a Single Polarity
8	2-4	Front Panel Controls
11	3-1	Calibration Adjustment Points and Plug-in Component Identification
13	4-1	Block Diagram of V34A and V35A
14	4-2	Stepping Switch, Kelvin-Varley Divider, and Transfer Switch Circuitry
17	4-3	Tabular Presentation of V34A and V35A Logic
17	4-4	Table: End-of-scan Logic
20	4-5	AND-OR Gates
21	4-6	Flip-flop Trigger Circuits
22	4-7A	Flip-flop Only
22	4-7B	Flip-flop with Trigger
23	4-8	A Board Parts Identification
24	4-9	A Board Block Diagram
25	4-10	Timing Chart
26	4-11	B Board Parts Identification
27	4-12	B Board Block Diagram
28	4-13	C Board Parts Identification
29	4-14	C Board Block Diagram
30	4-15	D Board Parts Identification
31	4-16	Error Amplifier Block Diagram
32	4-17	Two-relay and Four-relay Boards
32	4-18	Decimal Check Board
36	5-1A	Bottom View of Instrument Serial No. 11.3810 & on
37	5-1B	Bottom View of Instrument through Serial No. 11.3809
38	5-2	Dummy Amplifier used to Simulate Error Amplifier
39	5-3	Simplified Schematic of Logic Circuits
40	5-4	Voltage Source and Amplifier Input
41	5-5	Error Amplifier, Showing Test Points, Adjustments, and Parts Identification
42	5-6	Error Amplifier, Showing Shield Assembly Partially Disassembled to Provide Parts Identification
43	5-7	Error Amplifier Output Wave Form
44	5-8	Jumper Connections for 10-volt Calibrate Resistors
45	5-9	Zener Reference Voltage Supply, Showing Test Points, Adjustments, and Parts Identification
46	5-10	Simplified Schematic—Range and Function Control
47	5-11	Front View of Readout Showing Bulbs Correctly Positioned
49	6-1	Spares and Service Kit for V34A/V35A

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_08464

Section I

INTRODUCTION

The NLS V34A and V35A Digital Voltmeters are designed for users who require a highly accurate easily-maintained instrument possessing a high order of reliability.

Although discussed in detail elsewhere in this manual, the leading particulars of these instruments are summarized to illustrate how NLS has met user demand and to familiarize the reader with the instruments.

- **RELIABLE ACCURACY**

  The most important single quality required in a digital voltmeter is high reliability regardless of all the features that the instrument may otherwise possess. The V34A and V35A accuracy is achieved by reliance upon a minimum of critical components and is *not* due to careful balance among selected parts, the failure of one of which could cause the instrument to render faulty indications. Instead, through careful design, it has been possible to control only two factors to assure high level accuracy—the zener reference supply, and the NLS manufactured decade and range resistors. Thus, all other components can operate across a fairly broad band of tolerance without upsetting the accuracy of the instrument. By reducing the area of critical components to a minimum, the goal of "reliable accuracy" is approached.

- **MODULAR CONSTRUCTION**

  Except for the power supply, all circuit components are on plug-in boards; thus it is possible to keep the V34A and V35A operative with a minimum of down time. Hours spent in trouble shooting activities are now replaced by minutes spent in module replacement. This maintenance philosophy enjoys wide acceptance among instrument users who require that both trained and untrained personnel be able to service the instruments. Digital voltmeters are sometimes integrated into large systems in which any failure can cause the whole system to shut down. To minimize shut-down time, the V34A and V35A have been designed around a plug-in maintenance concept.

- **INDIVIDUAL PLUG-IN OIL BATH STEPPING SWITCHES**

  To further simplify maintenance and repair, the stepping switches are individually enclosed and oil-bathed so that the need for periodic lubrication is eliminated. Since the decade switches are interchangeable with each other, a defective one can be readily located by interchanging. Their mechanical wear is held to a minimum because the logic system in V34A and V35A eliminates considerable needless operation. Electrical wear, as well, is minimized because separate drive circuits are used, thus avoiding the necessity of passing high current through switch contacts. For these reasons, the spares requirement is minimal; under typical conditions of use, only one decade switch spare and one transfer switch spare need be kept per instrument.

- **RAPID-ACTION LOGIC**

  The V34A and V35A employ the fastest possible logic which can be used with stepping switches. With the NLS system it has been possible to achieve a significant reduction in the number of steps required to complete a reading. This contributes not only to rapid readout but also to long life and reduced maintenance cost.

- **PROVEN DESIGN**

  The V34A and V35A are the logical successors to our earlier instruments, the V34 and V35, and represent a continuation of development in solid state application for digital voltmeters. Thus, an additional element of reliability and accuracy has been achieved by the use of circuits in the field.

- **SNAP-IN READOUT ASSEMBLY**

  The plug-in concept applies not only to the several boards in the instrument but to the readout assembly as well. The lamps, Lucite panes and contacts may be removed from the front of the instrument without disturbing its position in a rack. A burnt-out lamp may be replaced in a few moments without the use of any tools.

- **FULL ONE-DIGIT RESOLUTION**

  The V34A (four digits) and the V35A (five digits) have full resolution of the least significant digit. The V35A is an improved version of the V35, the first digital voltmeter having a factual fifth digit with full sensitivity.

- **AUTOMATIC RANGE AND POLARITY SELECTION**

  Operation of the V34A and V35A instruments is simplified by automatic range and polarity selection. The decimal point and polarity signs properly adjust themselves regardless of input voltage. Besides this, the possibility of damage from having selected too low a range for measurement is eliminated. The user can indiscriminately apply an input of a very few millivolts, obtain his reading, and then apply up to 1000 volts to obtain a reading without having to manipulate any controls on the digital voltmeter. In addition, the voltage range may be selected manually when desired and locked into this range for DC measurements, or

for AC measurements when used with any NLS 125 Series AC/DC Converter. When used with the 125E AC/DC Converter, the V34A and V35A provide automatic range selection of AC voltages.

- **ISOLATED INPUT**
  The V34A and V35A inputs are completely isolated from the chassis. Measurements may be made with both signal "high" and signal "low," either above or below the chassis ground.

- **INSTANT VOLT-TO-RATIO CHANGEOVER**
  The simple operation of a front panel control permits rapid change from one mode of operation to another. No connections or disconnections need be made each time the instrument is to be shifted from one function to the other.

- **REMOTE CONTROL**
  The V34A and V35A provide plug connections for remote control. Except for ratio measurements, all functions normally controlled from the front panel may also be remotely controlled.

- **COMPACT, TRANSISTORIZED DESIGN**
  Since vacuum tubes are not used in the V34A or V35A, a remarkably compact design has been achieved. By using solid-state devices throughout, it has been possible to design and build an instrument which uses only five and one-quarter inches of standard rack space.

- **STANDARD INSTRUMENT FULLY EQUIPPED**
  The V34A and V35A are supplied complete; there is no need for accessory equipment to allow the instruments to work with printers. Self-contained contact closures are provided to actuate external indicating or printing devices.

The NLS Engineering Dept. will be pleased to help you with specific application problems and, of course, will gladly welcome your comments and suggestions. Your queries will be promptly answered.

Section I
INTRODUCTION

SPECIFICATIONS

	Model V35A 5 Digits	Model V34A 4 Digits
ABSOLUTE DC MEASUREMENTS		
Ranges	±0.0001 to ±999.99 volts in steps of ±9.9999/99.999/ 999.99 volts.	±.0001 to ±999.9 volts in steps of ±.9999/9.999/ 99.99/999.9 volts.
Accuracy	±0.01% of reading or ±1 digit	±1 digit
Resolution	±1 digit	±1 digit
Input impedance at balance	10 megohms	10 megohms
DC VOLTAGE RATIO MEASUREMENTS		
Range	±00.001% to ±99.999%	±00.01% to ±99.99%
Over-all accuracy	±0.005% or ±1 digit	±0.01% full scale
Input impedance at balance for signal	1000 megohms	1000 megohms
External reference voltage	Up to ±100 VDC	Up to ±100 VDC
Input impedance (for reference)	50 KΩ	50 KΩ
BALANCING TIME	2.3 seconds, maximum	1.9 seconds, maximum
RANGE CHANGING	Automatic or manual as selected.	
POLARITY INDICATION	Automatic	
AC MEASUREMENTS	Use accessory 125C Converter for manual or 125E for automatic range selection.	
POWER REQUIREMENTS	115 volts ±10%, 60 cps, 20 watts standby, 50 watts balancing.	
LOW LEVEL DC MEASUREMENTS	Use NLS 141 DC Preamplifier.	
SIGNAL GROUND CONNECTION	Signal ground is isolated from frame of instrument.	
WEIGHT	Net, 45 lbs.; shipping, 65 lbs.	
PAINT, FRONT PANEL	Light gray (MIL-E-15090B, Type 3, Class 1).	

Specifications are subject to change without notice.

Section II

INSTALLATION AND OPERATION

I. PRIMARY POWER

The V34A and V35A digital voltmeters operate on 105-125 volts AC, 50-60 cps. If the instrument is to be used with a 230-volt alternating current source, the primary windings of the power transformer may be wired in series. See the main schematic diagram for jumper connection coding when making this change.

NOTE

The AC power cord is polarized. Correct connection *must* be made with the power source. Despite the presence of a third grounding pin, there is no real assurance that the instrument will be correctly connected since the power outlets in many installations are erroneously wired. Be certain that the power source is in agreement with the power and grounding requirements of the instrument. Check Figure 2-1 against the power outlet.

Before connecting the instrument, see that it is protected by a fuse of the size shown on the main board assembly schematic. The fuse is readily accessible at the rear panel and may be extracted for inspection.

While the instrument will give readings as soon as it is turned on, a 15-minute warm-up period is required for very accurate readings. For calibration purposes, a 30-minute warm-up period is recommended. Once the instrument has been turned on, it may be left in the STANDBY position for an indefinite period. This position keeps the instrument in operational readiness without imposing any wear upon relays or stepping switches.

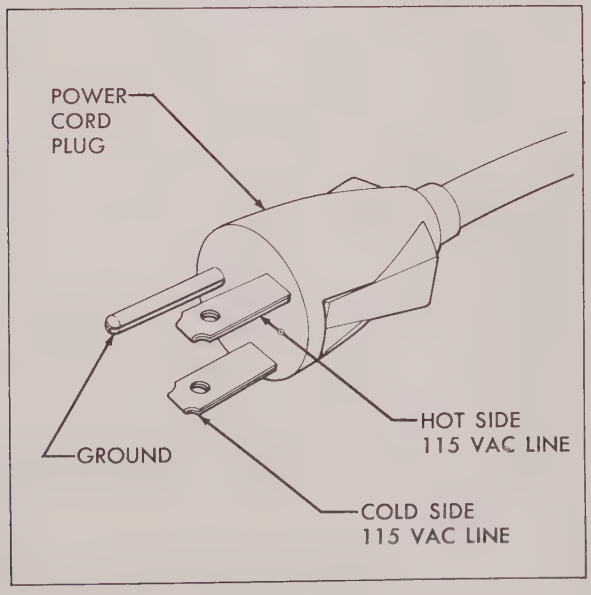


Figure 2-1 Power Plug Pin Coding

II. SIGNAL INPUT CONNECTIONS

The signal input cable terminates in three banana pins: red, black and blue. The red pin is "signal high," the black pin is "signal low," and the blue pin is "guard ground." See Figure 2-2.

NOTE

V34A/V35A instruments up to serial number 11.3810 internally connect the blue pin to the metal frame of the instrument. The frame is connected to earth ground through the third pin of the power plug in all instruments.

The red and black pins completely float and have no DC connection to other circuits. The black pin *must* always have a return path to the blue pin (provided by external connections). The blue pin should be connected to the common ground point of the circuit in which measurements are to be made. When measurements relative to the common ground are to be made, the black pin must also be connected to the common ground. When differential readings are to be taken, the black pin must be connected to the point with the lowest impedance to the common, and the red pin to the other point. If the impedance from the black pin to the blue pin is excessive, an error due to AC bias effects will result. This error will be minimized or totally eliminated if a capacitor of up to one microfarad value is connected from the blue pin to the black pin — providing the circuit under measurement permits. In addition, the circuitry being measured should be enclosed in a metal shield which is connected to earth ground.

When the digital voltmeter is used with an AC converter or preamplifier, or is used to measure voltages from power supplies connected to the 115-volt AC power line, the point to which the blue pin is attached should be grounded to earth for the most accurate results (see note in preceding paragraph).

Where it is undesirable to ground this point, the impedance to earth ground (from this point) must be kept at a minimum to reduce the offset caused by AC leakage currents coming from the circuit under test or from the preamplifier's or converter's power transformer.

For stable operation, the input leads must be shielded

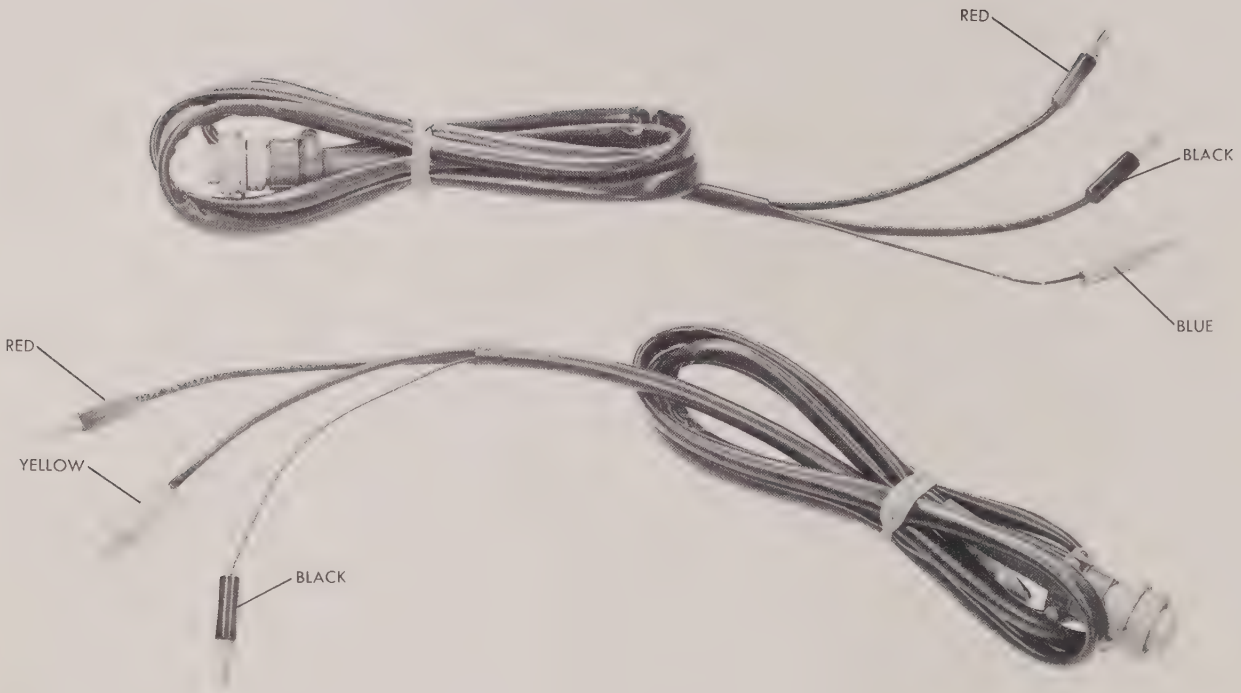


Figure 2-2 Top: Signal Input Cable
Bottom: External Reference Supply Cable

to minimize electrical pickup..This is particularly important when the impedance of the source to be measured is high. Excessive electrical noise pickup and ground loops can cause instability or an offset effect in the readings, or both.

III. EXTERNAL REFERENCE SUPPLY

An external reference supply connector is provided on the back of the instrument for use when the instrument functions as a ratiometer.

To measure positive and negative input voltages, the ratio-measuring circuits are connected as shown in Figures 2-3a and 2-3b. If it is necessary to measure inputs of a single polarity, External Reference A or External Reference B, as shown in Figure 2-3b, can be eliminated.

When the input voltage is zero or close to zero, the instrument may, if the signal is "noisy," display a polarity sign opposite to that of the reference voltage and read all 9's. Use a "dummy" reference voltage in place of the eliminated reference voltage to permit a smooth transition in readings (rather than a jump to a reading of all 9's) when close to zero. This connection provides much greater convenience when using the instrument to adjust the unknown voltage to zero. The dummy reference stability and value are unimportant if only the elimination of a sudden jump to a reading of all 9's is desired. For this reason, a single carbon-zinc or mercury cell may be used. If approximately correct readings are required of voltages whose polarities are opposite to that of the main reference supply, the dummy reference voltage should approximate the main reference voltage.

The V34A and V35A may use up to ±100 volts for the external DC reference supply. When used in the AUTO mode, the AUTO TRIGGER should be set at a position appropriate to the reference voltage used. The V34A, with an external reference of ±100 volts DC, requires

counter
that the AUTO TRIGGER be set in the full clockwise position; the V35A, with an external reference of ±100 volts DC, requires that the AUTO TRIGGER be set with the knob pointer at approximately 12 o'clock. These settings allow approximately a ±0.8 digit change in signal voltage before initiating a new scan. See also the AUTO TRIGGER discussion in Part VI of this section. Less than ±10 volts external reference may be used with the V35A (less than ±1 volt DC for the V34A) but with a resulting loss of resolution. Either instrument may be used with external DC voltages up to ±200 volts DC with some degradation of linearity due to heating of the voltage divider resistors.

IV. AC-DC CONVERTER CONNECTIONS

The following three connections are to be made when a converter is used.

1. The Model 125C and the 125E AC to DC Converters are connected directly to a 34-pin plug at the rear of the instrument. This plug connection supplies the converter with AC power controlled by the digital voltmeter POWER switch and makes connection to the AC range relays in the converter.
2. Connect the signal input cable to the converter.
3. A three-wire interconnecting cable is used to tie the output of the converter to the input of the digital voltmeter.

When the DVM is switched to VOLTS DC or to RATIO, relays in the converter pass the signal input directly through to the digital voltmeter. A special shorting plug is not required if the digital voltmeter is used without a converter.

V. PRINTER CONNECTION

A 75-pin plug at the rear of the instrument provides connection for use with a Clary printer, IBM typewriter, Flexowriter, and other printing devices.

All decade and symbol commons as well as all numbers and symbols are brought out to the 75-pin connector so that either serial or parallel printing may be used without modifying the digital voltmeter print harness. The print command is normally wired to provide Form C circuit closures for printers such as the IBM; however, several jumper wires must be moved to provide the correct print command for a Clary printer. Instructions for this modification are shown on Figure 5-10.

VI. CONTROLS

The V34A and V35A digital voltmeters are controlled from the front panel by the five controls shown in Figure 2-4. The following five subsections describe the function of each control.

1. POWER SWITCH—The POWER switch has four positions:
   - OFF—At OFF the instrument is completely de-energized.
   - ON—at ON the instrument operates but the print command is inhibited.

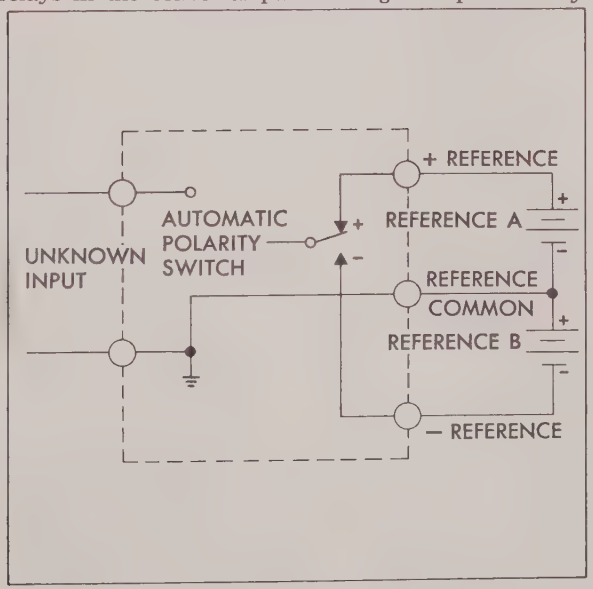


Figure 2-3A External Reference Supply Connection . . . To Measure Positive and Negative Input Voltages

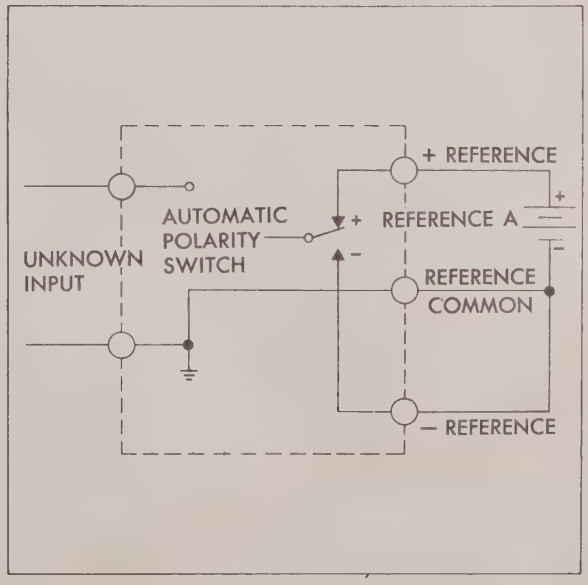


Figure 2-3B External Reference Supply Connection . . . To Measure Input Voltages of a Single Polarity

Section II
INSTALLATION AND OPERATION

Figure 2-4 Front Panel Controls

- PRINT—In this position a print command is issued automatically at the end of each reading. This position is used when operating a Clary printer, IBM typewriter, Flexowriter, etc. When a print command is issued, the instrument locks up and cannot be made to scan until the data printer so commands or the POWER switch is returned to ON. See Part VII of this section.
- AUTO PRINT—This position functions in the same manner as position 3 except that if an error in excess of the number of digits set in by the auto trigger exists at the end of scan, the print command is inhibited. In the AUTO or CONTINUOUS mode, the instrument automatically recycles until a valid reading is obtained (the single-scan mode is not used with the PRINT position).

NOTE

If the instrument is turned on while the input leads are shorted, the readings may oscillate between positive and negative. This is normal. Open the input leads to permit the instrument to complete its first scan and be ready for operation.

2. FUNCTION SWITCH—This control has the following three positions:
   - RATIO—For use with an external reference supply.
   - DC—For measuring DC voltage; automatic range and polarity selections are built into the instrument.
   - AC—For measuring AC voltage; the NLS 125C or 125E AC/DC converter is used with the instrument set in this position.
3. MODE SWITCH—This control offers an unusual flexibility of action. It has the following four positions:
   - SINGLE SCAN—In this spring-loaded position, the instrument makes a single voltage measurement and locks the readout.
   - STANDBY—This position keeps the instrument warm while avoiding needless stepping switch and relay wear. It also permits the readout to be locked in order to preserve a particular reading.
   - AUTO—This is the most commonly used position. With this setting, the instrument scans whenever there is a variation in the signal input amplitude but does not scan when the input is stable. The degree of change necessary to initiate a new scan is regulated by the AUTO TRIGGER control.
   - CONTINUOUS—In this position, the instrument continually scans whether or not the signal input amplitude shows any variation. This position is normally used when the instrument is part of a printer-scanner system.
4. RANGE SWITCH—This control has four positions:

- AUTO – Range is selected automatically for DC, and automatically for AC, when used with the NLS 125E AC/DC Converter.
- 1000 – 000.00 to 999.99 (V35A – DC)
  000.0 to 999.9 (V34A – DC)
  0000.0 to 0999.9 (V35A – AC)
  000.0 to 999.9 (V34A – AC)
- 100 – 00.000 to 99.999 (V35A – DC)
  00.00 to 99.99 (V34A – DC)
  000.00 to 099.99 (V35A – AC)
  00.00 to 99.99 (V34A – AC)
- 10 – 0.0000 to 9.9999 (V35A – DC)
  0.000 to 9.999 (V34A – DC)
  00.000 to 09.999 (V35A – AC)
  0.000 to 9.999 (V34A – AC)

5. AUTO TRIGGER CONTROL – This control is effective only in the AUTO mode for visual readout, but is effective in all modes when used with a data recorder when the POWER switch is in the AUTO PRINT position. The AUTO TRIGGER control sets the plus-minus limits within which the signal may vary *without* triggering another scan when using the instrument visually rather than in the PRINT or AUTO PRINT positions. For the same setting of the AUTO TRIGGER control, the same plus-minus limits apply, within which the instrument will issue a print command (when used with a data recorder and with the POWER switch set at AUTO PRINT). Note that the setting of this control has no effect upon the resolution of the instrument; the loop gain is set for a nominal 0.4 of the least significant digit, and remains at this value during every scan regardless of the front-panel control settings.

The AUTO TRIGGER control circuitry is nominally set so that the control covers an approximate range of ±0.8 to ±100 digits. The range may be extended to ±1000 or more digits by a simple adjustment of R-616, as explained in the Maintenance Section, should individual requirements dictate a change.

When this control is set to MAX and the MODE switch to AUTO, a ±.00008 volt departure from the signal voltage producing a null with the digital potentiometer voltage will initiate a DVM scan in the basic range. It is apparent that at signal-voltage values lying "between digits" (that is, an input of .83625 and a reading of .8362 or .8363), any slight disturbance of the signal will initiate a scan. The AUTO TRIGGER control may be set as requirements dictate; approximate settings are as follows:

9 o'clock, 75 digits
12 o'clock, 15 digits
3 o'clock, 1-2 digits

VII. OPERATION WITH DATA RECORDERS

When the POWER switch is set at PRINT or AUTO PRINT, as described in Part VI of this section, the instrument will operate as follows:

1. A "print command" pulse is issued to command data printing.
2. The instrument's reading remains locked (regardless of MODE switch position) until the data printer issues a momentary Form C contact transfer "print complete" signal to the DVM. Upon completion of the contact transfer, the instrument reads and prints again when in the CONTINUOUS mode; when in the AUTO mode, the instrument reads and prints again when the input changes from its previous value.

VIII. REMOTE CONTROL

Remote Control of all front-panel functions, except for RATIO, is available at J-116. Schematic Dwg. No. 15057 at the end of the manual shows the method of remote control. All, any one, or any combination of the functions may be remotely controlled.

If the remote control cable is longer than six feet, the wires to Pins Y, Z, AA, CC, EE, JJ, and KK should be shielded; the wires to Pins A and B should be a shielded, twisted pair.

Section III

CALIBRATION

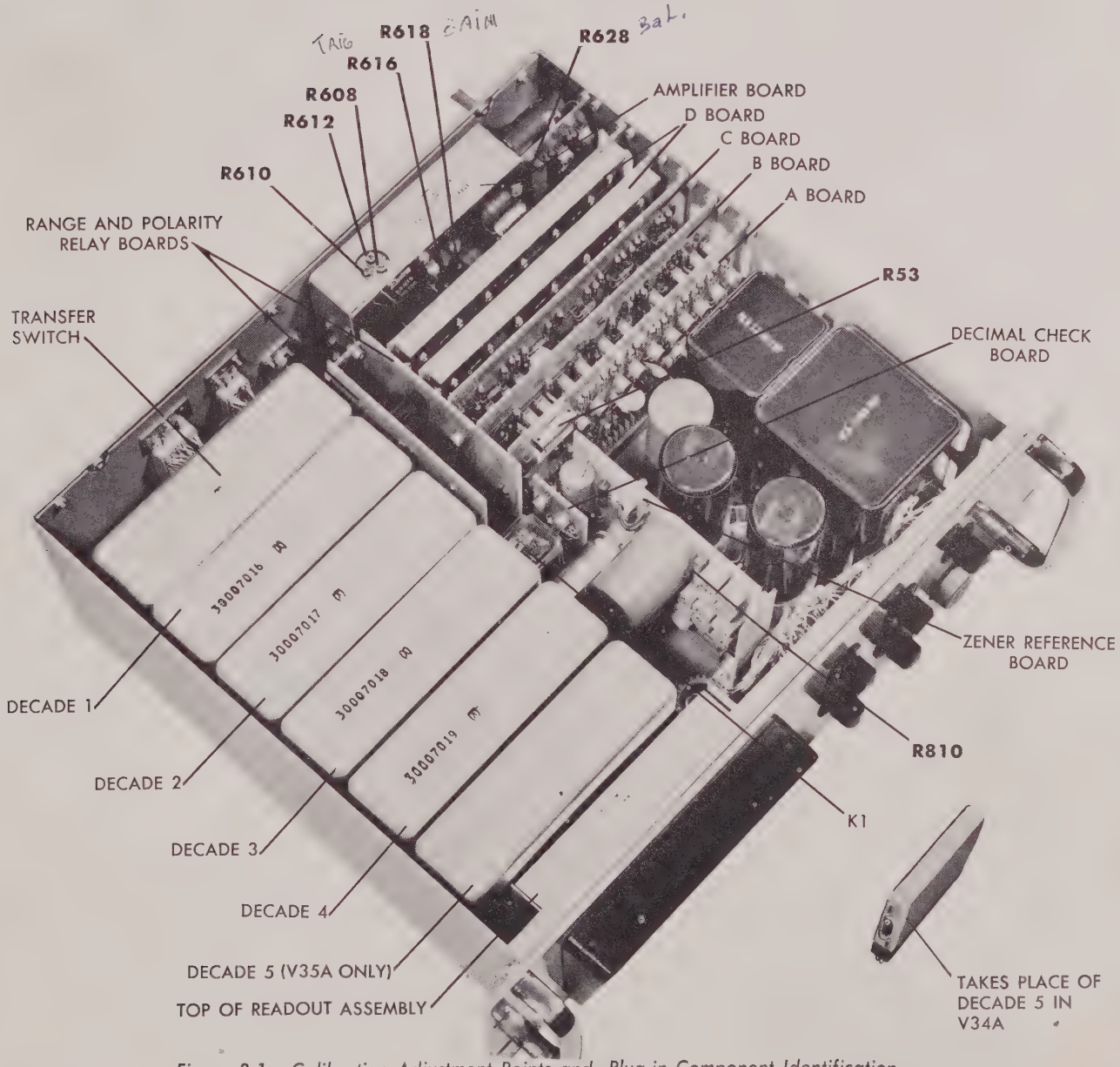


Figure 3-1 Calibration Adjustment Points and Plug-in Component Identification

While the V34A and V35A are similar, the calibration procedure for each is slightly different. The following items (or equivalents) are required:

1. Two voltage dividers, one with 10:1 ratio, one with 100:1 ratio; each divider calibrated for a 10-megohm load; each divider at least .005% accurate.
2. Stable but not necessarily accurate DC sources of of 9 to 9.999, 90 to 99.99, and 900 to 999.9 volts.
3. Stable and accurate to .005% (or better) DC source of between 9 and 9.9999 volts. Nine standard cells in series will provide 9.1656 volts.

Allow the instrument to warm up for thirty minutes; remove the top cover. The V34A/V35A tables give the procedure. Follow the steps in the sequence listed. The physical location of each adjustment potentiometer is shown in Figure 3-1.

Section III
CALIBRATION

V34A CALIBRATION STEPS

Step No.	Source[1]	Ratio[2]	Readout Display[3]	Adjustment	Purpose
1R	+9 V	10:1	.9 V		
2	+9 V	1:1	9 V	R-608	
3	−9 V	10:1	.9 V		
4	−9 V	1:1	9 V	R-608	
5R	+90 V	10:1	9 V		
6	+90 V	1:1	90 V	R-610	
7	−90 V	10:1	9 V		Ranging
8	−90 V	1:1	90 V	R-610	
9R	+900 V	100:1	9 V		
10	+900 V	1:1	900 V	R-612	
11	−900 V	100:1	9 V		
12	−900 V	1:1	900 V	R-612	
13	+9 V STD. CELLS		9 V	R-810	Absolute
14	−9 V STD. CELLS		9 V	R-810	Accuracy

V35A CALIBRATION STEPS

Step No.	Source[1]	Ratio[2]	Readout Display[3]	Adjustment	Purpose
1R	+90 V	10:1	9 V		
2	+90 V	1:1	90 V	R-608	
3	−90 V	10:1	9 V		
4	−90 V	1:1	90 V	R-608	
5R	+900 V	100:1	9 V		Ranging
6	+900 V	1:1	900 V	R-610	
7	−900 V	100:1	9 V		
8	−900 V	1:1	900 V	R-610	
9	+9 V STD. CELLS		9 V	R-810	Absolute
10	−9 V STD. CELLS		9 V	R-810	Accuracy

Notes to Calibration Tables:

1. The voltage source indicated is not exactly at the voltage listed but is within the range shown under Item 2 in the first paragraph of this section. Item 3 covers the Absolute Accuracy source requirement.
2. The 1:1 ratios indicated are to be obtained with the voltage divider connected so that the 10-megohm load is constant for all adjustments.
3. The readout in Steps 1 through 4 must have digital correspondence (without regard for decimal-point position) within specifications. The same requirement also applies to Steps 5 through 8, and in the V34A to Steps 9 through 12 as well.
4. "R" in the Step No. column means record the reading at that point. In each case the 3 following steps must show correspondence.

Section IV

THEORY OF OPERATION

I. BASIC THEORY

The NLS Series 30A Digital Voltmeters (Models V34A and V35A) are basically closed loop servos in which a feedback voltage is driven to equal an unknown input voltage. The value of this feedback voltage is then displayed on the digital readout.

The Models V34A and V35A are essentially of the same design with only minor differences. This section describes the Model V35A. Where differences exist, they are described.

Figure 4-1 is a block diagram of the DVM. The unknown input voltage is fed through the input attenuator to one side of a non-shorting chopper. The feedback voltage is fed to the other side of the chopper. The output of the chopper is fed to the error amplifier which compares the input with the feedback and produces one of three outputs: U, an up pulse (signal more positive than the feedback), D, a down pulse (signal more negative than the feedback), or UD, no U or D pulse (signal equal to the feedback). These three pulse lines are fed to the digital logic circuits. The timing generator drives the chopper and controls the timing of the digital logic circuits.

The transfer switch is at the heart of the scan logic used in the DVM. It routes the output pulses from the digital logic circuits to the proper stepping switch in the Kelvin-Varley divider (or to the range attenuator relays) and selects the proper output from the Kelvin-Varley divider to be used as the feedback voltage. The novel scan logic of this DVM utilizes the normal output of the Kelvin-Varley divider, as well as other outputs from various points in the divider.

The Kelvin-Varley divider is fed by a precision reference voltage supply. The output voltage of this supply is very closely controlled by a stable, low-temperature-coefficient zener diode mounted in a crystal oven.

The input attenuator divides the signal by 1:1, 10:1, 100:1, and in the V34A, 1000:1. The input attenuator also controls the position of the decimal point in the digital readout.

II. THE KELVIN-VARLEY DIVIDER AND SCAN LOGIC.

Figure 4-2 is a simplified schematic of the stepping-switch-controlled Kelvin-Varley divider and the transfer switch circuitry.

The Kelvin-Varley divider is a decade voltage divider in which each decade has two outputs and two inputs. Each decade is identical and is composed of one 12.5kΩ and eleven 5kΩ precision resistors and a stepping switch, all contained in a plug-in oil bath can. The switch is so wired that two adjacent 5kΩ resistors are always paralleled by 10kΩ of resistance (12.5kΩ in parallel with the 50kΩ input resistance of the following decade). Thus the resulting input resistance is 50kΩ and the output voltage across the two resistors is one-tenth of the input voltage. In addition, this voltage may be positioned at any 10% increment of the input voltage. Each decade

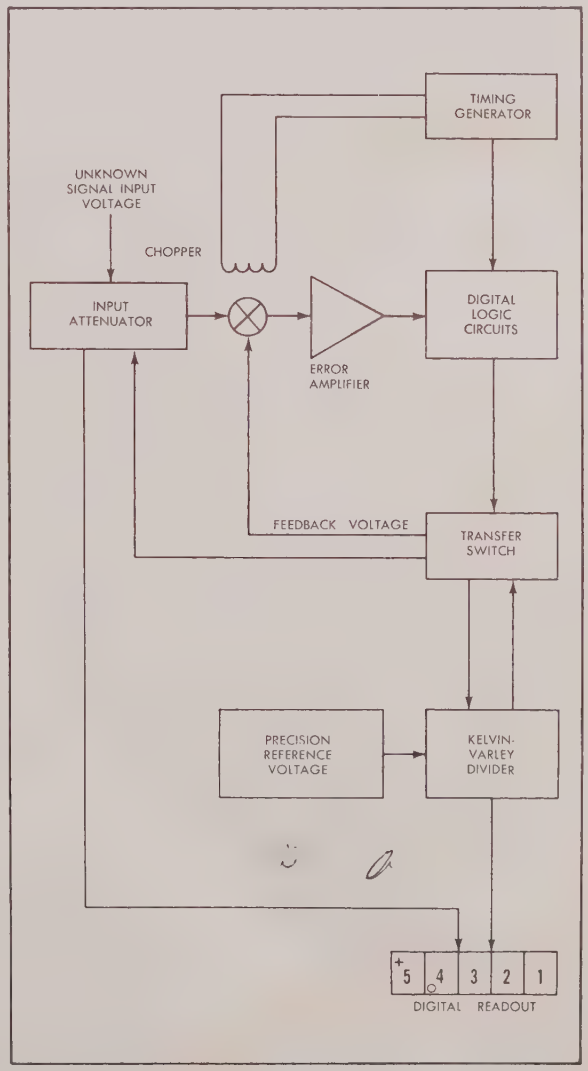


Figure 4-1 Block Diagram of V34A and V35A

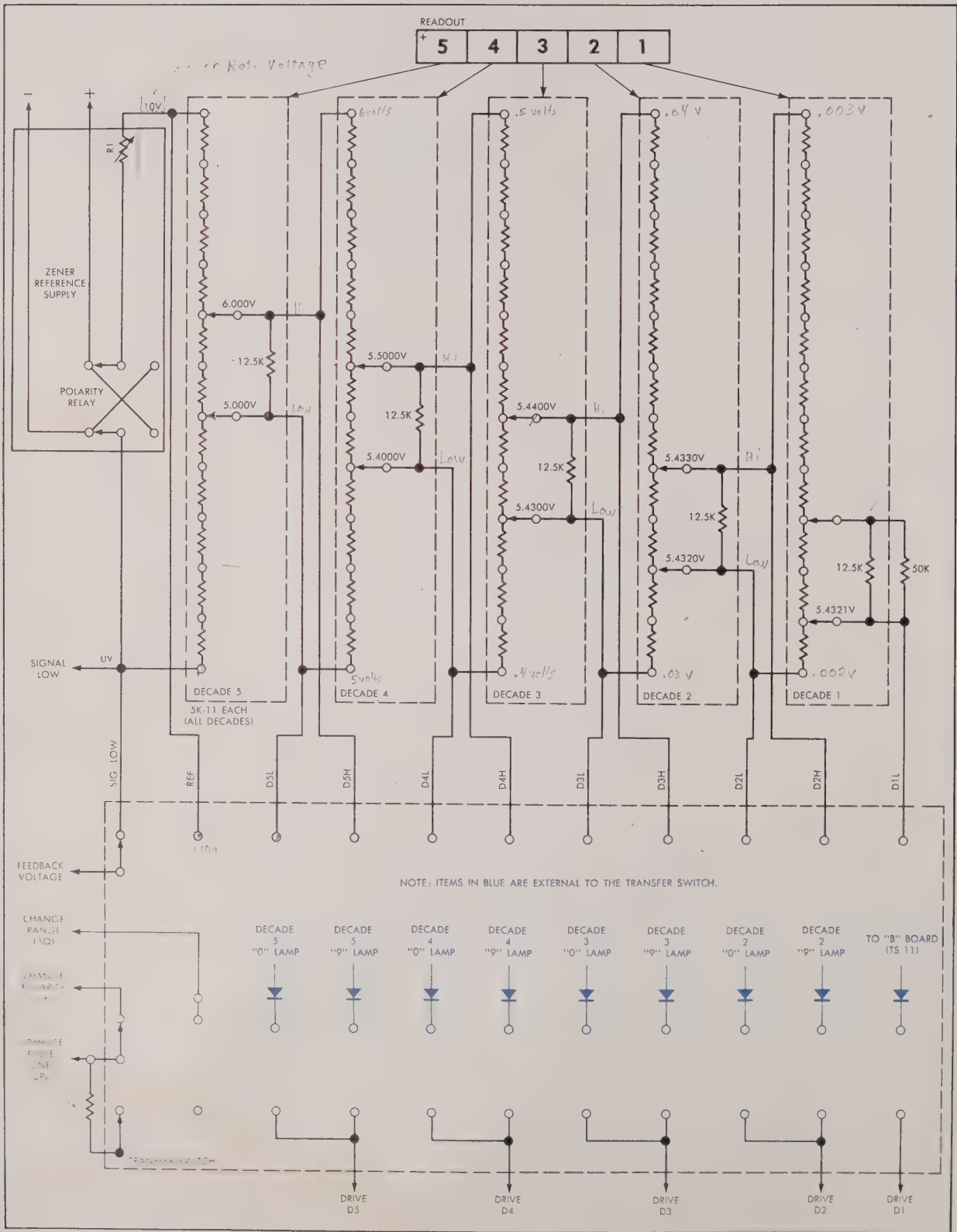


Figure 4-2 Stepping Switch, Kelvin-Varley Divider, and Transfer Switch Circuitry

therefore has a low and a high input and a low and a high output. Shown here in tabular form are the various output voltages for a low input of 0 volt and a high input of 10 volts. Two additional levels on the stepping switch provide data to the readout and to the external printer connector.

Digit Displayed In Readout	Low Output Voltage	High Output Voltage
0	0	1
1	1	2
2	2	3
3	3	4
4	4	5
5	5	6
6	6	7
7	7	8
8	8	9
9	9	10

As shown in Figure 4-2, the decades are so connected that each decade floats on the output of the preceding decade, dividing in turn the input voltage by ten. If each decade is adjusted in sequence to bracket the signal, starting with Decade 5 and proceeding through to Decade 1, each approximation will be more accurate, resulting in a final accuracy of five decimal digits in the V35A or four digits in a V34A. In these two instruments, the transfer switch scans the outputs of each decade in proper sequence. One level of the switch selects the feedback and the other two levels route the drive pulse to the correct stepping switch coil. The outputs of the error amplifier, in conjunction with the logic circuits, drive each decade so that the two outputs bracket the signal. Note that the error amplifier must not load the divider or error will result.

Figure 4-2 shows the zener reference supply feeding through the polarity relay and the calibrating resistor R-1 to the divider. R-1 is adjusted so that the input voltage to the divider (Ref) is exactly 10 volts. The 50kΩ resistor on the output of the divider is added to properly load Decade 1. Note that only the low output of Decade 1 is used since it is the final output of the divider, and bracketing is not necessary.

To determine whether a particular decade is positioned correctly or must be changed, the logic circuits require three sources of information: amplifier output, polarity, and transfer switch position. Polarity information is necessary since the amplifier output determines only whether the signal is more positive or negative than the feedback, not whether it is numerically greater or smaller. Exact transfer-switch position data is not utilized since the logic is the same for every other position of the transfer switch. The odd-even flip-flop is used to supply this information to the logic circuits. This flip-flop changes state each time the transfer switch moves.

The timing generator controls both the chopper drive and the stepping switch drive. Each sample of the chopper will generate a pulse out of the amplifier, U, D, or $\overline{UD}$ on one of three pulse lines. For each amplifier pulse, one stepping-switch drive pulse is generated.

Stepping switches operate in the following manner: A pulse energizes the switch coil which, in turn, cocks a spring, without moving the switch. At the end of the pulse, the spring moves the switch. Thus the switch moves only one step for each pulse. Because of this, a pulse may be routed to the coil of a stepping switch through its own contacts since the switch does not move during the pulse. This characteristic is utilized without the need for passing high-current pulses through the contacts since each stepping switch has its own power amplifier.

The output of the logic circuits is the Compute Pulse Line (CPL). If conditions call for changing a particular decade, a pulse will occur on this line. This is called CP and is "read": Compute Pulse. This pulse is routed through the transfer switch to the power amplifier associated with the proper decade switch, and the decade switch will move one step. If a pulse does not occur on CPL, the transfer switch will move one step. This is called $\overline{CP}$ and is "read": No Compute Pulse.

In order for a particular decade to be properly positioned, two conditions must exist: the low output must be equal to or less than the signal, and the high output must be greater than the signal. When scanning, the transfer switch first connects the low output of a decade to the feedback. If the low output is not equal to or less than the signal, CP's will occur and the decade switch will be driven one step at a time until the required condition is met. Since the switch moves in one direction "0" to "9," the switch will move up to "9" and on the next step will go to "0." At this point, the feedback should be equal to or less than the signal. As a result, CP's will stop, producing $\overline{CP}$, and the transfer switch moves to the high output position. If the feedback is not equal to or less than the signal when the decade has reached "0" (due to the signal changing or some previous error), the logic circuits will generate a CP. This could cause the decade to step continuously if it were not for the transfer switch connecting a fail-safe diode from the "0" readout light to CPL. When the decade

Section IV
THEORY OF OPERATION

switch gets to the "0" position, the diode conducts, shorting any CP's to ground, resulting in $\overline{CP}$, and the transfer switch moves on to the next position; the scan is completed, and the error is corrected on the next scan.

When the transfer switch connects the high output of a decade to the feedback, CP's are generated unless the feedback is greater than the signal. If the feedback should equal the signal at this point, a CP must be generated since an exact null cannot be reached unless the decade switch is advanced one more step. (Example: a 6.0000-volt signal cannot be nulled with Decade 5 in the "5" position.) If CP's still exist when the decade reaches the "9" position, they are shorted to ground by a fail-safe diode connected to the "9" light through the transfer switch resulting in $\overline{CP}$. As before, this prevents the decade from continually stepping, never reaching a null.

Automatic polarity and ranging are accomplished by relays. Two relays are used for polarity, one to switch the zener reference supply, and one to provide the readout and print data. Four relays are used for ranging, two to switch the input attenuator, and two to provide readout and print data. All of the relays are connected as flip-flop loads. The range relays are driven by two commutatively coupled flip-flops, which can provide four ranges. (Four ranges are used in the V34A, but only three ranges are used in the V35A.) At the start of each scan, the range flip-flops are set, putting the DVM into the lowest range. If a higher range is necessary to null the signal, CP's will step the range attenuator one range at a time, until the proper range is reached. When the RANGE switch is not in the AUTO position, the range flip-flops are locked in the condition commanded by the RANGE switch.

Figure 4-3 presents, in tabular form, the logic of the V34A and V35A instruments. In conjunction with Figure 4-2, several of the symbols used on the schematics are explained. The "A" flip-flop referred to is zero for all positions of the transfer switch except position 11 (D1L) and is set when the transfer switch moves into position 11. The flip-flop is zeroed at the beginning of each scan when the transfer switch moves from position 11 to position 1 (sig. low). Since the high output of Decade 1 is not used as a feedback, the logic for Decade 1 is slightly different from that of the other decades. The A flip-flop "informs" the logic circuits that the transfer switch is in position 11.

At the start of a scan, the range flip-flops are set to the lowest range condition, and the transfer switch is moved from position 11 to position 1. The first test is for polarity. The feedback is signal low, the odd-even flip-flop is odd (OE), CPL is connected to ΔP, and the A flip-flop is zero. If the signal is positive, the amplifier output will be a U pulse, and if negative, the output will be a D pulse. If the polarity relay is in the positive position and a D pulse occurs, the polarity is incorrect and must be changed. In this event, the logic causes a CP to occur, and the polarity is changed. At the next sampling time, the polarity will be correct; $\overline{CP}$ will occur, and the transfer switch will move to position 2 (Ref). Conversely, a CP will be generated if the polarity relay is in the negative position, and a positive signal (U pulse) occurs.

The second test is for range. The feedback is Ref (input to the bridge), the odd-even flip-flop is even ($\overline{OE}$), and CPL is connected to ΔQ. If the polarity is now positive and the signal is over 10 volts, a U pulse will occur, causing a CP which will change the range to the next higher range. CP's will continue until the correct range is reached, at which point $\overline{CP}$ will occur and the transfer switch will move to position 3. Should the polarity relay be in the negative position, CP would be generated by D pulses. Should the signal be exactly ± 10 (or ± 100) volts (± 1, ± 10, or ± 100 volts for the V34A) no U or D pulse would occur, but $\overline{U}\,\overline{D}$ causes CP to be generated, stepping the range attenuator to the next higher range.

Figure 4-3 shows that the logic is the same for all even steps of the transfer switch. Similarly, the logic is the same for all odd steps. UD causes a CP for all even steps except Step 12. When in Step 12, A being set eliminates the generation of CP's by $\overline{U}\,\overline{D}$.

All of the information contained in Figure 4-3 can be summed up with an equation, if the terms used are understood. As an aid to interpreting the equation, the following list of symbolic equivalents is offered:

Symbol	English Equivalent
U	Up pulse
D	Down pulse
$\overline{U}\,\overline{D}$	Neither up nor down pulse
OE	Odd transfer-switch positions
$\overline{OE}$	Even transfer-switch positions
P	Positive polarity
$\overline{P}$	Negative polarity
$\overline{A}$	Transfer switch not in position 11
•	And
+	Or
=	Exists if

LOGIC STEP	TRANSFER SWITCH POSITION	FEEDBACK	ODD-EVEN FLIP-FLOP	POLARITY	AMPLIFIER OUTPUT NECESSARY FOR A COMPUTE PULSE (CP)	COMPUTE PULSE WHEN NO UP OR DOWN PULSE? ($\overline{UD}$)	"A" FLIP-FLOP	COMPUTE PULSE LINE (CPL) CONNECTED TO:
1	1	Signal Low	Odd (OE)	Pos. (P) Neg ($\overline{P}$)	Down (D) Up (U)	No	Zero ($\overline{A}$)	Change Polarity ($\triangle$ P)
2	2	Reference (REF)	Even ($\overline{OE}$)	Pos (P) Neg ($\overline{P}$)	Up (U) Down (D)	Yes	Zero ($\overline{A}$)	Change Range ($\triangle$ Q)
3	3	Decade 5 Low (D5L)	Odd (OE)	Pos (P) Neg ($\overline{P}$)	Down (D) Up (U)	No	Zero ($\overline{A}$)	Decade 5 (D5)
4	4	Decade 5 High (D5H)	Even ($\overline{OE}$)	Pos (P) Neg ($\overline{P}$)	Up (U) Down (D)	Yes	Zero ($\overline{A}$)	
5	5	Decade 4 Low (D4L)	Odd (OE)	Pos (P) Neg ($\overline{P}$)	Down (D) Up (U)	No	Zero ($\overline{A}$)	Decade 4 (D4)
6	6	Decade 4 High (D4H)	Even ($\overline{OE}$)	Pos (P) Neg ($\overline{P}$)	Up (U) Down (D)	Yes	Zero ($\overline{A}$)	
7	7	Decade 3 Low (D3L)	Odd (OE)	Pos (P) Neg ($\overline{P}$)	Down (D) Up (U)	No	Zero ($\overline{A}$)	Decade 3 (D3)
8	8	Decade 3 High (D3H)	Even ($\overline{OE}$)	Pos (P) Neg ($\overline{P}$)	Up (U) Down (D)	Yes	Zero ($\overline{A}$)	
9	9	Decade 2 Low (D2L)	Odd (OE)	Pos (P) Neg ($\overline{P}$)	Down (D) Up (U)	No	Zero ($\overline{A}$)	Decade 2 (D2)
10	10	Decade 2 High (D2H)	Even ($\overline{OE}$)	Pos (P) Neg ($\overline{P}$)	Up (U) Down (D)	Yes	Zero ($\overline{A}$)	
11	11	Decade 1 Low (D1L)	Odd (OE)	Pos (P) Neg ($\overline{P}$)	Down (D) Up (U)	No	Set (A)	Decade 1 (D1)
12	11	Decade 1 Low (D1L)	Even ($\overline{OE}$)	Pos (P) Neg ($\overline{P}$)	Up (U) Down (D)	No	Set (A)	

Figure 4-3 Tabular Presentation of V34A and V35A Logic

The equation which expresses the information in Figure 4-3 may now be stated: (parentheses indicate the 5 alternatives)

$$CP=(OE\cdot P\cdot D)+(OE\cdot \bar{P}\cdot U)+(\overline{OE}\cdot P\cdot U)+(\overline{OE}\cdot \bar{P}\cdot D)+(\overline{OE}\cdot \bar{U}\bar{D}\cdot \bar{A})$$

The following paragraph, although difficult to read, expresses in English the essence of the equation:

A compute pulse exists if the odd-even flip-flop is odd and the polarity relay is positive and a down pulse occurs; or if the odd-even flip-flop is odd and the polarity relay is negative and an up pulse occurs; or if the odd-even flip-flop is even and the polarity relay is positive and an up pulse occurs; or if the odd-even flip-flop is even and the polarity relay is negative and a down pulse occurs; or if the odd-even flip-flop is even and neither an up nor a down pulse occurs and the transfer switch is not in position 11.

Following ranging, the transfer switch scans through decades 5, 4, 3, 2, and finally decade 1. At this point, the scan is complete and the readout will display the unknown signal input voltage to five places in the V35A and to four places in the V34A. Note that the logic employed in these instruments avoids the necessity of "homing" each decade switch to 0 at the beginning of every scan, thus increasing speed and extending switch life. If the signal should change from −5.5555 volts to −5.5655 volts, only decade 3 moves, or if the signal changes from −5.5555 volts to +5.5555 volts, only the polarity relay changes.

The "fail-safe" diodes for decade 1 are located on the B board, and are routed to transfer switch position 11 (TS11).

To make a V34A out of a V35A, decade 5 switch assembly is replaced by an adapter. This adapter is wired to simulate decade 5 switch in the 0 position, thus attenuating the reference voltage by ten. The wire from position 2 of the transfer switch is moved from Ref to decade 5 High, and the wires from positions 3 and 4 are moved to SIG. LOW. Shorting wires in the adapter simulate both a 9 and a 0 in order to short out any CP's which would attempt to change the non-existent fifth decade.

III. END-OF-SCAN LOGIC

When the transfer switch reaches the eleventh position, the end-of-scan logic performs the functions done by the transfer switch in positions 1 through 11 except that the feedback is not switched; it remains connected to the output of the Kelvin-Varley divider at position 11 of the transfer switch. Additionally, print, standby, and scan command switching are accomplished by this logic.

Four flip-flops (termed FF), "A," "OE," "ES," and "PD" are associated with the end-of-scan logic as well as timing pulses "T" and "$\bar{T}$," gate pulses "C" and "$\bar{C}$" and error pulses "U" and "D." The "A" FF is always zero except at the end of scan, and serves to lock the transfer switch in the eleventh position. The "OE" FF is zero on the even numbered steps of the transfer switch, and set on the odd numbered steps. During the end of scan, the "OE" FF continues to flip, as though the transfer switch had positions 12 and 13. The "ES" FF is always zero until all computing is completed, at which time the "ES" FF is set. The "PD" FF is set *only* after the "ES" FF is set and the POWER switch is in the PRINT or AUTO PRINT position (in AUTO PRINT only if no U or D pulse is present).

The sequence of operation is shown in Figure 4-4. In Step 1, at the ½ bit time, drive power is removed from the transfer switch and the OE FF is set. In Step 2, at approximately ¾ bit time, the transfer switch has been spring driven to position 11; and the A FF is set by TS11. When the A FF is set, the transfer switch is locked in position 11. As with the other decades, both low-output and high-output logic are performed on decade 1 even though only the low output is used as feedback. The one exception is that $\bar{U}\bar{D}$ is inhibited by the A FF being set; thus $\bar{U}\bar{D}$ does not produce CP's in position 11. During Step 2, low-output logic is performed, and decade 1 is driven until the feedback is equal to or less than the signal. Once this condition is reached, $\overline{CP}$ occurs and the OE FF is zeroed; in both the low and high output logic, Figure 4-4 assumes that decade 1 is initially correct and $\overline{CP}$ exists, in order to show the timing. During Step 3, high-output logic is performed, and decade 1 is driven until the feedback is equal to or greater than the signal, $\overline{CP}$ occurs, the OE FF is set, and the ES FF is set. At this point the POWER switch setting determines the events to follow. The main body of the chart shows the sequence with the POWER switch set to ON, while the bottom portion of the chart shows the sequence with the POWER switch set to a print position. If the POWER switch is set to ON, the OE FF is zeroed by T when time = 3 in Step 5. The zeroing of the OE FF removes a lockout on the A FF, allowing the A FF to be zeroed in Step 6. The A FF may be zeroed in Step 6 by T in CONTINUOUS SCAN and SINGLE SCAN, or by U or D in AUTO. When the A FF is zeroed in Step 6, the ES FF is zeroed in Step 7 and a new scan is initiated.

LOGIC STEP	TIME (BITS) AUTO SCAN	TIME (BITS) CONT. SCAN	STATE OF FLIP-FLOPS (See Inset Below for PD) A	OE	ES	FF	TRANSFER SWITCH	COMPUTE PULSE LINE (CPL)	CONDITION FOR CHANGE OF STATE
0	0	0	Zero	Zero	Zero		Unlocked	Unshorted	Automatically
1	½	½	Zero	Set	Zero		Unlocked	Unshorted	Transfer Switch moves to Position 11
2	¾	¾	Set	Set	Zero		Locked	Unshorted	No Compute Pulse ($\overline{CP}$)
3	1½	1½	Set	Zero	Zero		Locked	Unshorted	$\overline{CP}$
4	2½	2½	Set	Set	Set		Locked	Shorted	POWER Switch ON — Automatically for Print Positions — See Inset
5	3	3	Set	Zero	Set		Locked	Shorted	CONTINUOUS SCAN — Automatically AUTO. SCAN — U or D exists
6	3 1/100	3½	Zero	Zero	Set		Unlocked	Shorted	Automatically
7 (New Scan)	3½	4½	Zero	Set	Zero		Unlocked	Unshorted	

LOGIC	BITS	A	OE	ES	PD		NOTES
4	2½	Set	Set	Set	Zero	POWER Switch Set to PRINT.	▷ Time Variable depending on Print Feedback Signal.
4+	3½	Set	Zero	Set	Set		
5	▷	Set	Zero	Set	Zero		
4	2½	Set	Set	Set	Zero	POWER Switch Set to AUTO. PRINT; U or D exists.	
5	3 1/100	Set	Zero	Set	Zero		
6	4 1/100	Zero	Zero	Set	Zero		
4	2½	Set	Set	Set	Zero	POWER Switch Set to AUTO. PRINT; no U or D.	
4+	3½	Set	Zero	Set	Set		
5	▷	Set	Zero	Set	Zero		

Figure 4-4 Table: End-of-Scan Logic

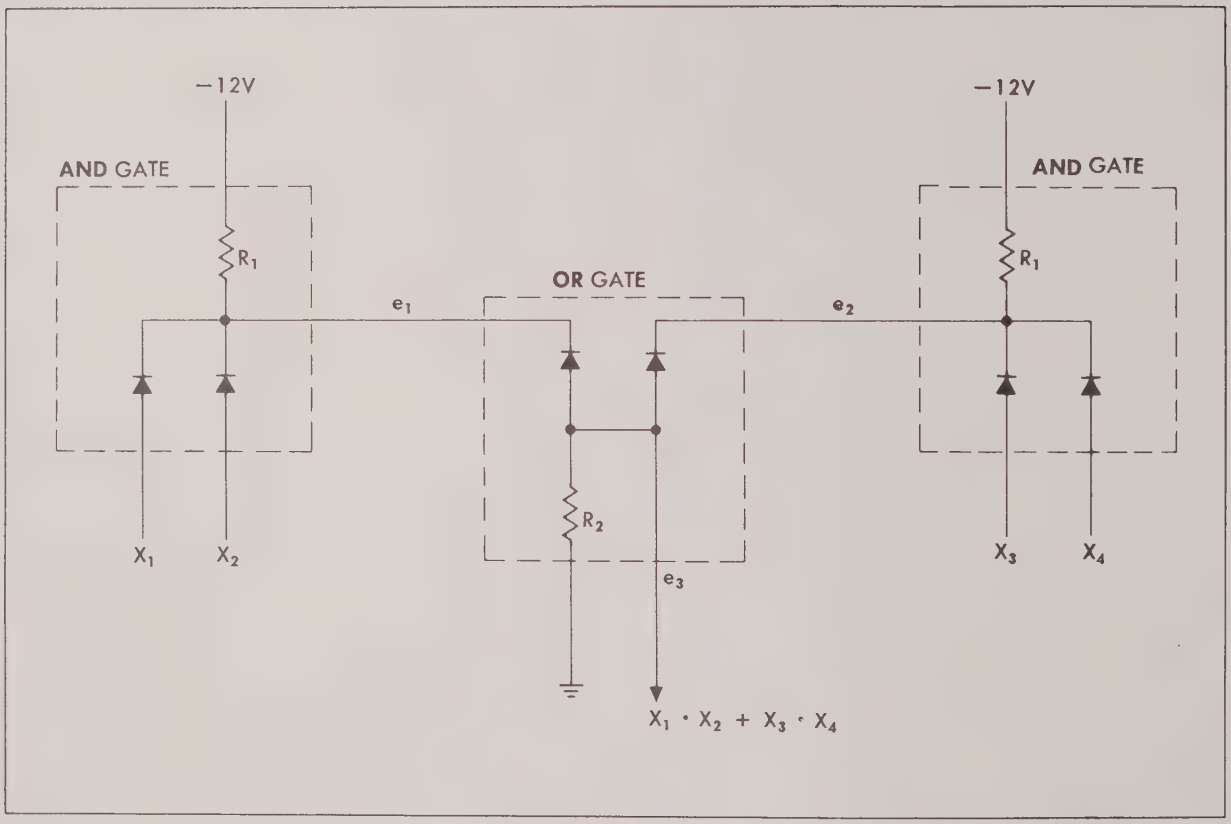


Figure 4-5 AND-OR Gates

When the POWER switch is set to PRINT (see chart inset), the OE FF is not zeroed at Bit 3 but is zeroed ½ bit later at Step 4+ and PD is set; the PD FF remains set and the instrument is locked until a print feedback signal zeros PD. From this point on, the logic is the same as in the ON position.

When the POWER switch is in the AUTO PRINT position and U or D occurs, the logic is the same as in the ON position except that logic Steps 5, 6, and 7 occur at different times (see Figure 4-4). As long as U or D exists, the instrument will continuously recycle and will not isssue a print command. When the POWER switch is set to AUTO PRINT and U or D do not exist, the sequence is the same as for PRINT.

Fail-safe "0" and "9" light lockout of CPL is required in decade 1 as it is in the other decades. This is accomplished on the B board by a diode matrix and an emitter follower.

IV. LOGIC CIRCUITRY

Figure 4-5 is an example of AND-OR gates. If X_1 or X_2 (or both) are at ground potential, e_1 will be at ground. If both X_1 and X_2 go negative, e_1 will be pulled negative by R_1. Thus if both X_1 and X_2 are negative, e_1 will be negative. The same applies to e_2 with respect to X_3 and X_4. The ohmic value of R_2 is always several times that of R_1. If both e_1 and e_2 are at ground, e_3 will also be at ground, but if either e_1 or e_2 goes negative, e_3 will also go negative. The output of the circuit in Figure 4-5 may be expressed: $X_1 \cdot X_2 + X_3 \cdot X_4$. This means that the output is negative if X_1 and X_2 are negative or X_3 and X_4 are negative.

Figure 4-6 is a sample flip-flop trigger circuit used in the V34A and V35A. X_1, X_2, and X_3 are fed into an AND gate. When they all go negative, e_1 will be pulled negative by R_1. Since R_1 is very large compared to R_3 and R_4 in parallel, the current through C_1 will be small, and the voltage at e_2 will remain near zero. When X_1,

Section IV
THEORY OF OPERATION

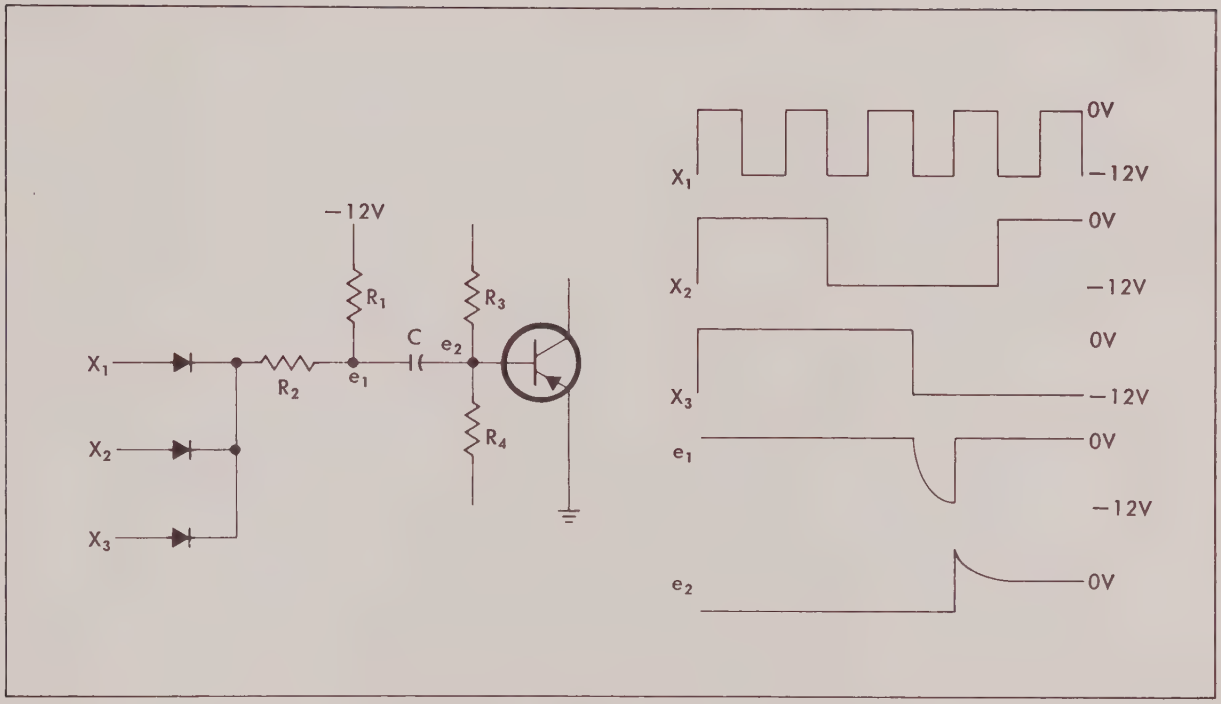


Figure 4-6 Flip-flop Trigger Circuits

X_2, or X_3 goes to ground, a surge of current limited by R_2 (R_2 is small compared to R_3 and R_4) will flow through C_1, causing e_2 to go positive. The PNP transistor is turned off when e_2 goes positive with respect to ground.

Figure 4-7A is a schematic of a typical logic FF used in the V34A and V35A. The FF has two outputs, X and $\overline{X}$. If X is negative, $\overline{X}$ is 0, and if X is 0, $\overline{X}$ is negative. Figure 4-7B illustrates the flip-flop with its trigger circuits. The 27kΩ resistors connected to the collectors serve the same function as R_1 in Figure 4-6. The dotted circuit at the bottom of the diagram illustrates an additional set trigger. Parallel triggers such as this accomplish OR logic without the necessity for AND-OR gates.

V. A BOARD

Located on the A board are the timing generators, a compute matrix, and the compute pulse FF. This board is shown in Figure 4-8. Figure 4-9 is a block diagram of the plug-in assembly and Figure 4-10 illustrates the timing of the pulses generated. The mono stable FF is triggered from the 60-cycle power source and provides an 11⅔ MS delay from the trigger time. The timing binary FF divides the frequency by two, providing a 30-cycle square wave, the bit rate of the DVM. These two waves are added to drive the bi-stable chopper drive FF, producing an asymmetrical wave with a 5 MS duration and a 30-cycle repetition rate. The same addition triggers the mono stable gate FF to produce an approximate 1½ MS duration and 30-cycle repetition rate.

The center-tapped chopper coil is driven by CD and $\overline{CD}$. At the end of the 5 MS square wave, C is set, and approximately ⅓ MS later the amplifier produces U, D, or no output. If the logic equation derived in Part II of this section is satisfied, the compute matrix will pass the positive-going trailing edge of C and set the compute pulse FF, thus causing a CP to be generated on CPL. As described previously, this CP may be shorted to ground by the 0 or 9 lights (Part II of this section) or by the ES FF (Part III of this section).

VI. B BOARD

This board is shown in Figure 4-11. Located on the B board, as shown in Figure 4-12, are the ES, A, OE,

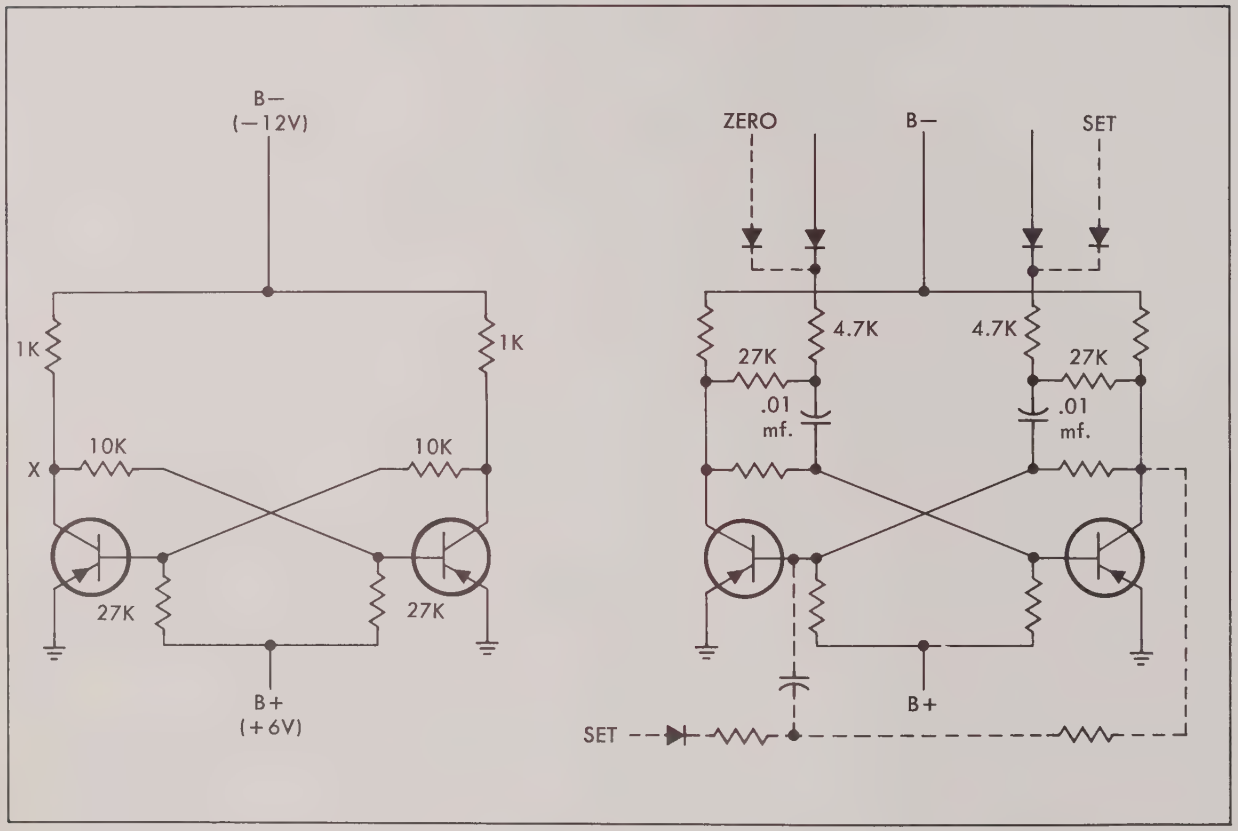


Figure 4-7A Flip-flop Only

Figure 4-7B Flip-flop with Trigger

and PD flip-flops associated with the end-of-scan logic, an inverter and an emitter follower. The functions of all except the inverter are described in Part III of this section. The inverter, in conjunction with T and $\overline{C}$, provides the inverse($\overline{CP}$)of CP which drives the transfer switch on D_T. As previously described in Part III of this section, the transfer switch is locked out in position 11 when the A FF is set by TS11. A diode connected from $\overline{A}$ to D_T provides this lock-out function. Thus, except at TS11, a $\overline{CP}$ (no CP) will drive the transfer switch, while a CP will drive a compute relay or decade, one step for each time bit.

All FF's in the V34A and V35A are triggered by positive pulses as described in Part IV of this section except the A FF. Figure 4-10 shows the A FF trigger diodes reversed. The triggers for the A FF operate in the same manner as in the other FF's except that the trigger turns the transistor on rather than off.

VII. C BOARD

The C board, shown in Figure 4-13, contains the FF's which drive all of the relays in the DVM. A block diagram is shown in Figure 4-14. The print command (PC) FF is a 50 to 100 millisecond monostable flip-flop. It drives the print command relay, and is triggered by the setting of A when the POWER switch is in the PRINT position. ΔQ (transfer switch position 2) drives the Q FF through an inverter. Q in turn drives the R FF. Q and R are connected to the coils of the two relays which operate the range attenuator. $\overline{Q}$ and $\overline{R}$ are connected to the coils of the two relays which provide range data to the readout and the external printer. The Q and R FF's are set to the lowest range at the beginning of each scan by the zeroing of A. ΔP (Transfer switch position 1) drives the P FF through an inverter. P is connected to the coil of the relay which switches the zener reference

Section IV
THEORY OF OPERATION

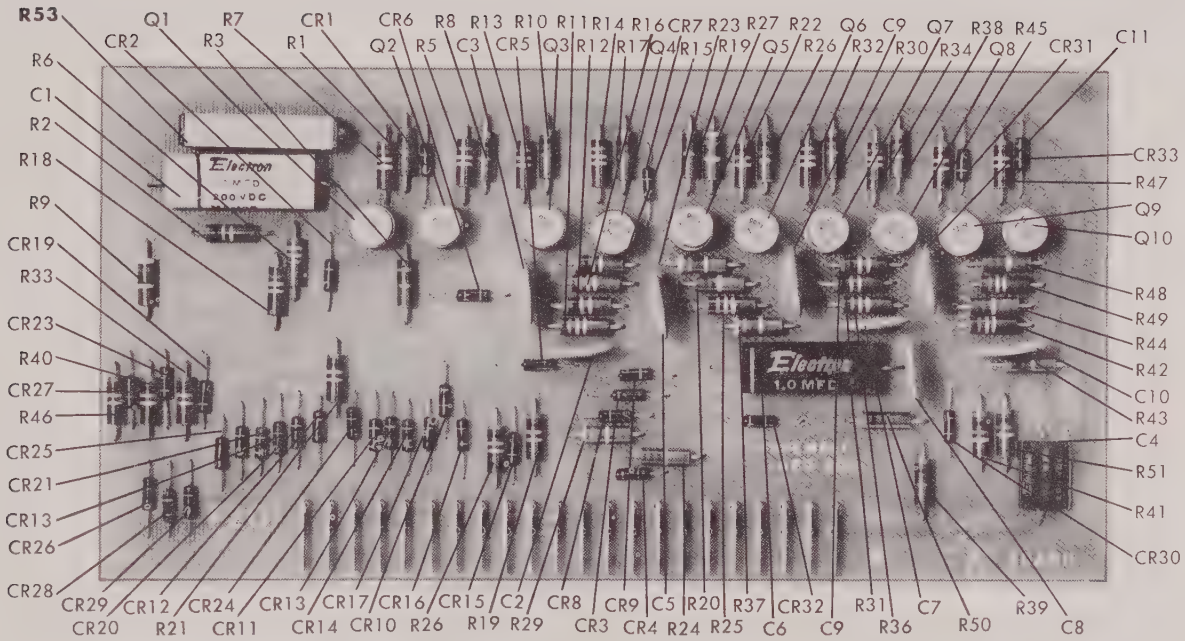


Figure 4-8 A Board Parts Identification

supply. $\overline{P}$ is connected to the coil of the relay which provides the polarity data. CP's on ΔQ or ΔP change the range or polarity FF's.

The grounding of R_1L, R_2L, R_3L, or R_4L, provides means of locking the Q and R FF's in a selected manual range. In the V35A, R_1L is grounded for the 10-volt range, R_2L for the 100, and R_3L for the 1000. In the V34A, R_2L is grounded for the 10-volt range, R_3L for the 100, and R_4L for the 1000. The grounding of any of these points shorts ΔQ to ground; Q and R remain in the condition commanded by the RANGE switch. (When Q or R, or both, are grounded, the grounded FF or FF's cannot be set by A at the beginning of each scan.) ACL is grounded when the FUNCTION switch is set to AC. When ACL is grounded, the DVM is locked in positive polarity and the second range.

VIII. D BOARD

The instrument contains two identical D boards as shown in Figure 4-15. Each board has three identical stepping-switch power amplifiers. See Schematic 11420-500, sheet 2. The power amplifier consists of a driver (2N1374) and power transistor (2N1540). A diode, capacitor, and 4.7KΩ resistor enable the power transistor to absorb the energy stored in the magnetic field of the stepping switch coil. The C's are connected to stepping-switch coils. The D's are connected to the transfer switch, or to the B board (D_T). The −15 volt supply is slightly higher than the B− voltage used throughout the DVM. The other ends of the coils are connected to this −15 volt supply.

IX. AMPLIFIER

Figure 4-16 is a block diagram of the error amplifier. Full views are shown in Figure 5-3 (Maintenance Sec-

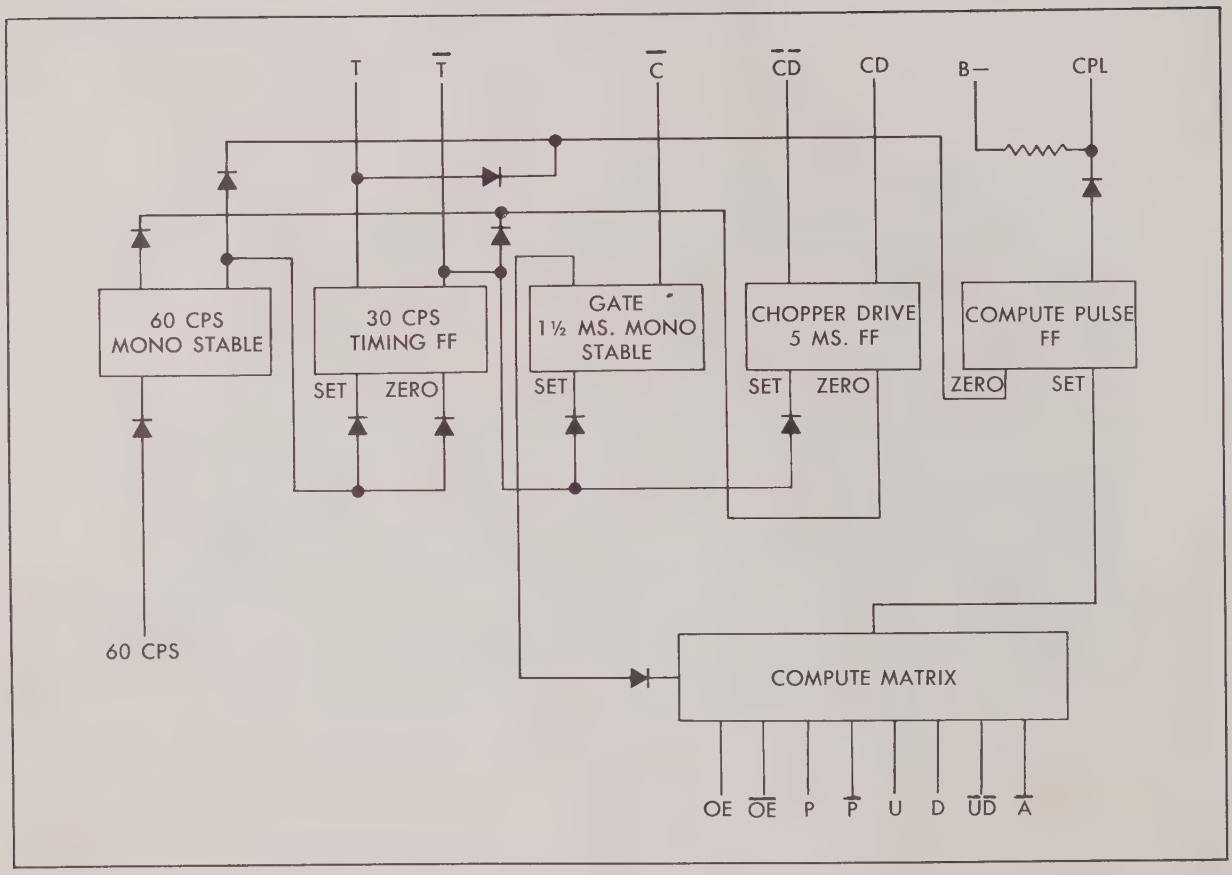


Figure 4-9 A Board Block Diagram

tion). The unknown signal is fed through the input attenuator to one side of the chopper. The input attenuator is controlled by the Q and R relays. The voltage across the chopper is limited to a nominal ±15 volts by the zener diode, CR-601. Potentiometer R-612 calibrates the fourth range (attenuated by 1000) for the V34A; the V35A does not use the fourth range.

C-602 is shorted across the primary of isolation transformer T-601 for approximately 28 milliseconds. Approximately 5 milliseconds before the zero bit time, the chopper switches C-602 to the signal and C-602 charges toward the signal. Since the other side of C-602 is connected to the feedback, it is not required that C-602 be charged to the exact signal voltage; only direction of error is involved. It is desirable that C-602 be charged close to the signal in order to avoid excessive losses in the resultant error signal to T-601. The input attenuator has a maximum output impedance of 1 megohm; thus C-602 charges to approximately .95 of the signal. At zero bit time, the chopper is driven, and approximately 350 microseconds later transfers C-602 in shunt with the primary of T-601. Unless the feedback exactly equals the signal, energy has been stored in C-602; this energy is "dumped" into T-601, resulting in an approximate 1-microsecond pulse to Q-601. The direction of current flow depends upon the polarity of the error. The error pulse is amplified by a 3-stage transformer-coupled amplifier. The gain of the amplifier is controlled by R-618. If the signal is more positive than the feedback, the UP (U) FF will be set. If the signal is less positive than the feedback, the DOWN (D) FF will be set. The U and D FF's are cross coupled so that if one of them is set, the other is held zeroed. If either U or D is set $\overline{U}\,\overline{D}$ will be held at ground by Q-610. R-628 is adjusted so that the sensitivity of the U and D FF's are equal. $\overline{C}$ is at −12 VDC (set) most of the bit. At zero bit time, $\overline{C}$ goes to ground (zeroed) and is set approximately 1½ milliseconds later. When $\overline{C}$ is set, U and D are zeroed and held in this condition until

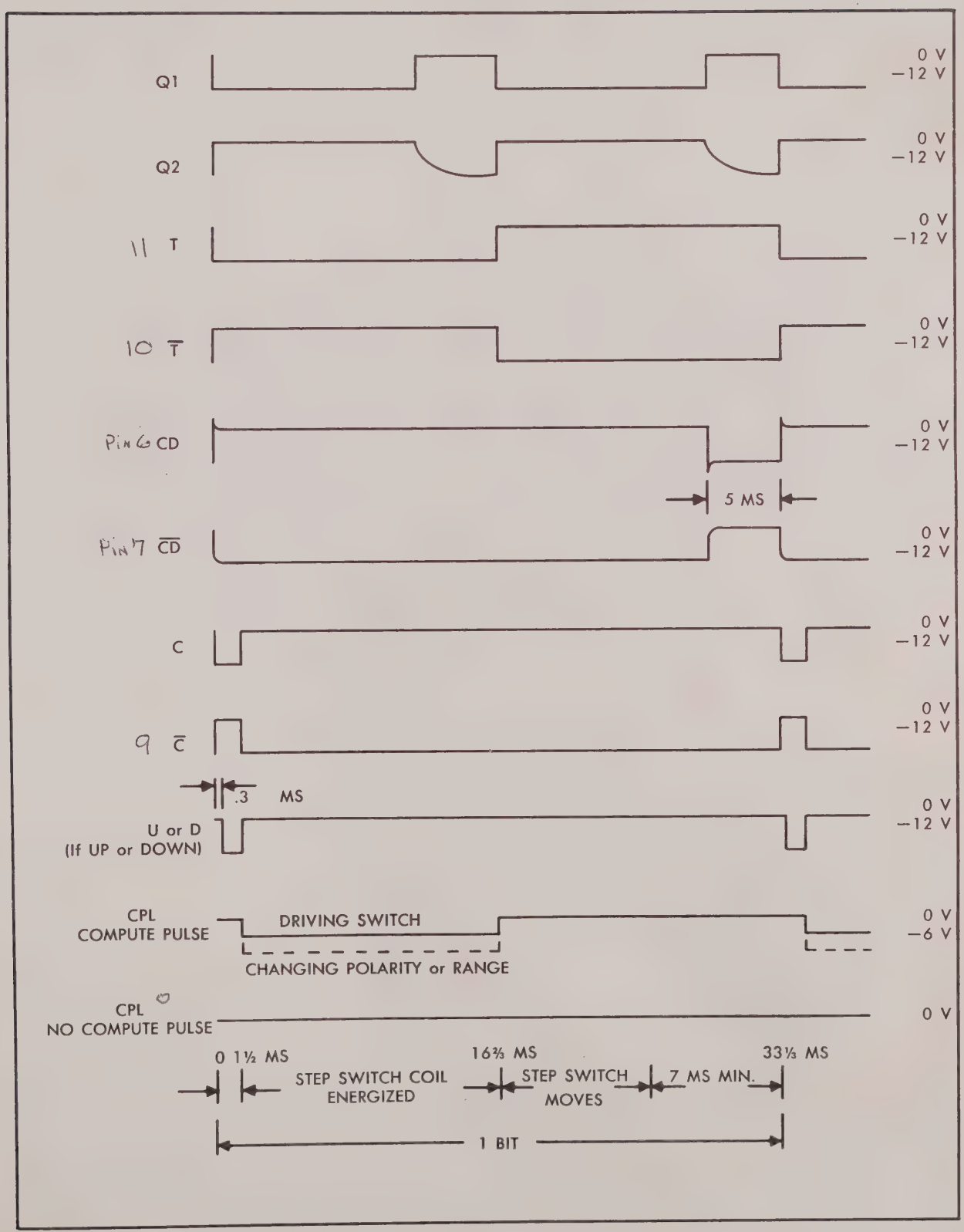


Figure 4-10 Timing Chart

Section IV
THEORY OF OPERATION

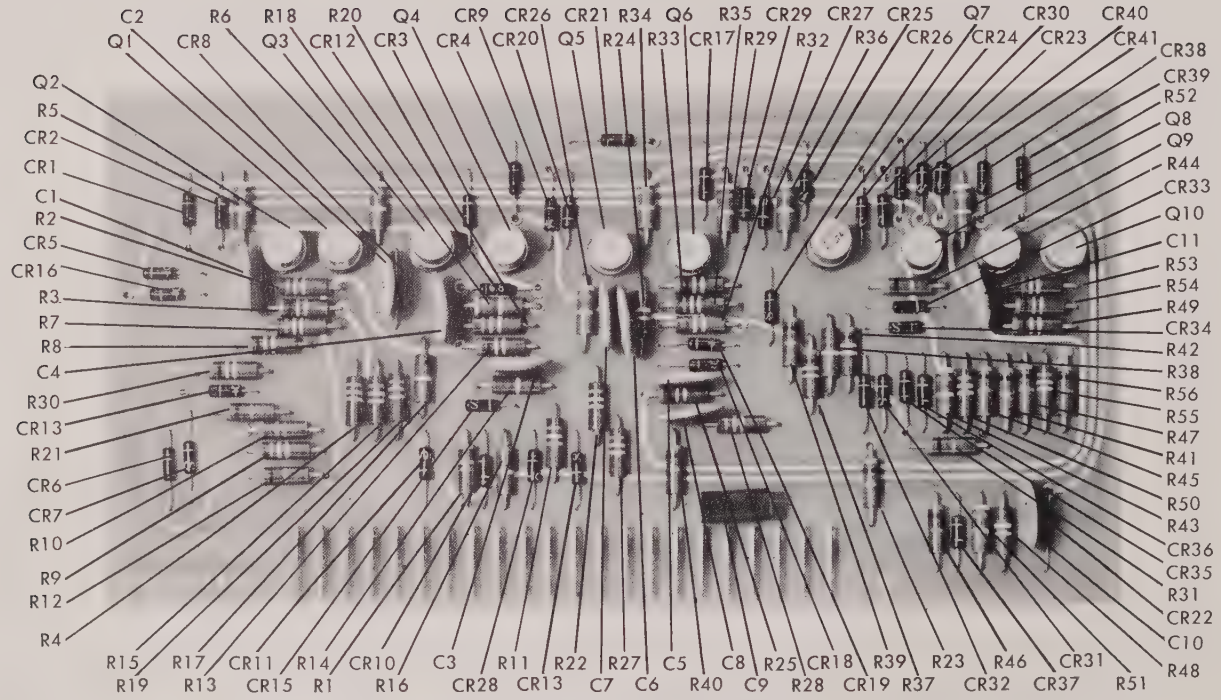


Figure 4-11 B Board Parts Identification

after $\overline{C}$ has been zeroed approximately 250 microseconds. This delay is accomplished by the network composed of CR-615, C-608, and R-653.

When in the AUTO mode and in AUTO PRINT, Q-605 determines the error necessary to produce U or D when at the end of scan (ES). Q-605 is connected as an emitter follower series regulator; the voltage at its emitter will be approximately that of its base. This voltage is derived by the voltage divider composed of R-622, R-616, and R-103. R-103 is a 2.5 K ohm log rheostat located on the front panel and labelled AUTO TRIGGER. R-616 adjusts the maximum digits error required to trigger a scan, and is adjusted with R-103 set to MIN (full CCW), which grounds the auto lead. Nominally, R-616 is adjusted for ±100 digits, but up to 1000 digits can be obtained. Q-604 serves as a gate which clamps the emitter of Q-605 to the zener regulated (nominally 4 volts) positive voltage source at all times except at the end of scan. Thus, the voltage supplied to the emitter resistors of Q-601 and Q-602 is held at 4 volts during scan by Q-604, and is held at a lesser voltage set by R-103 at the end of scan, resulting in a reduction of gain in Q-601 and Q-602.

X. ZENER REFERENCE SUPPLY

The zener reference supply, shown in Figure 5-9 in the Maintenance Section and shown schematically on 11420-050, sheet 2, at the end of the manual, consists of a rectifier and a current regulator driving a zener-diode bridge circuit. The current regulator greatly reduces the effects of varying power-line voltage and the

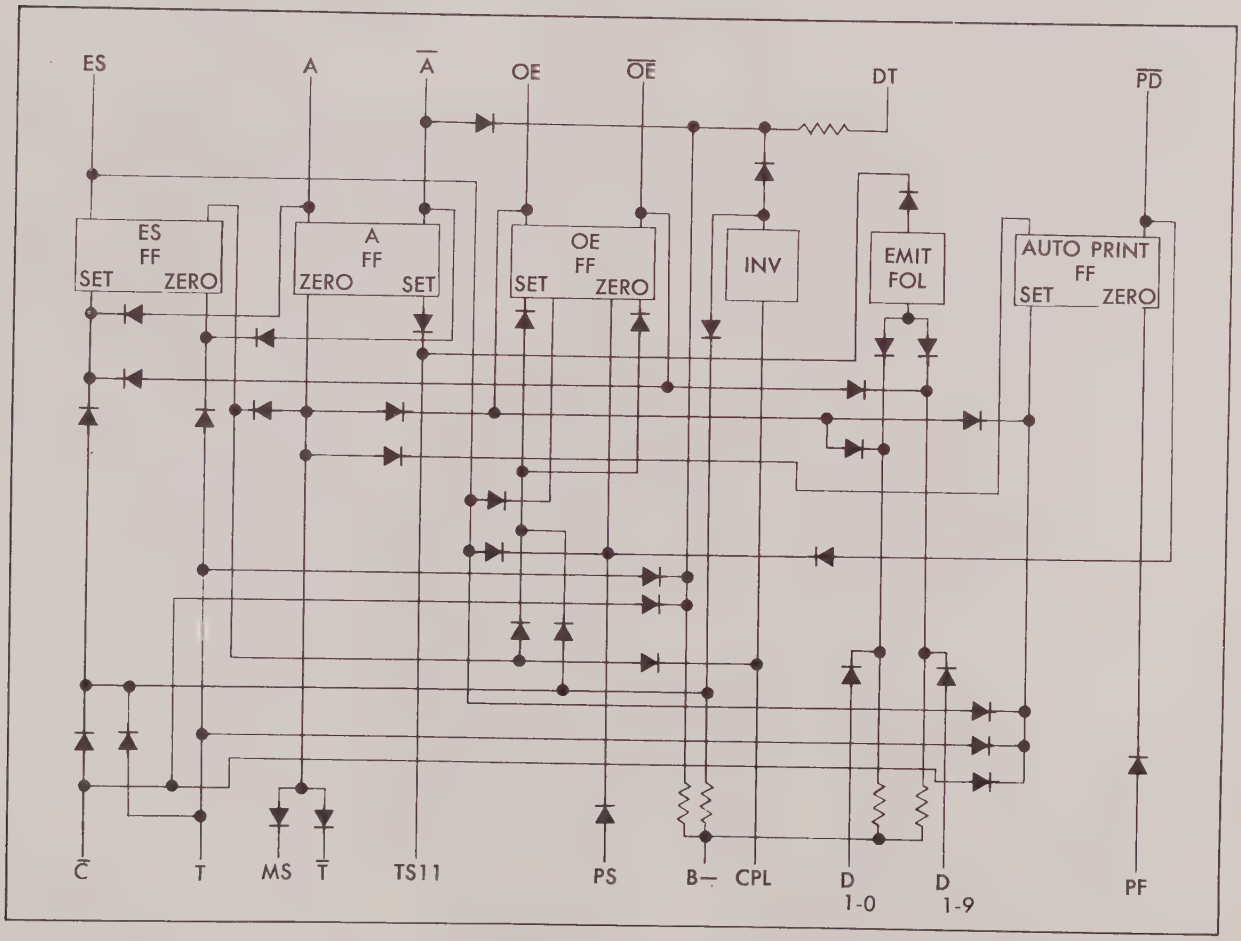


Figure 4-12 B Board Block Diagram

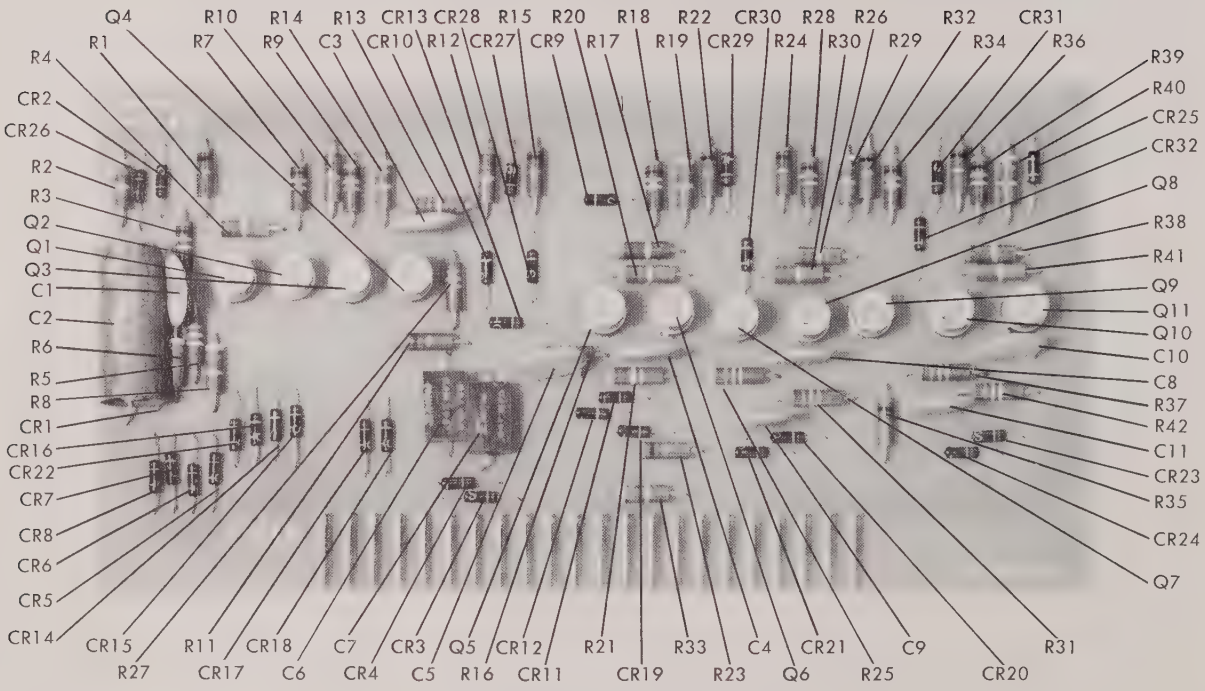


Figure 4-13 C Board Parts Identification

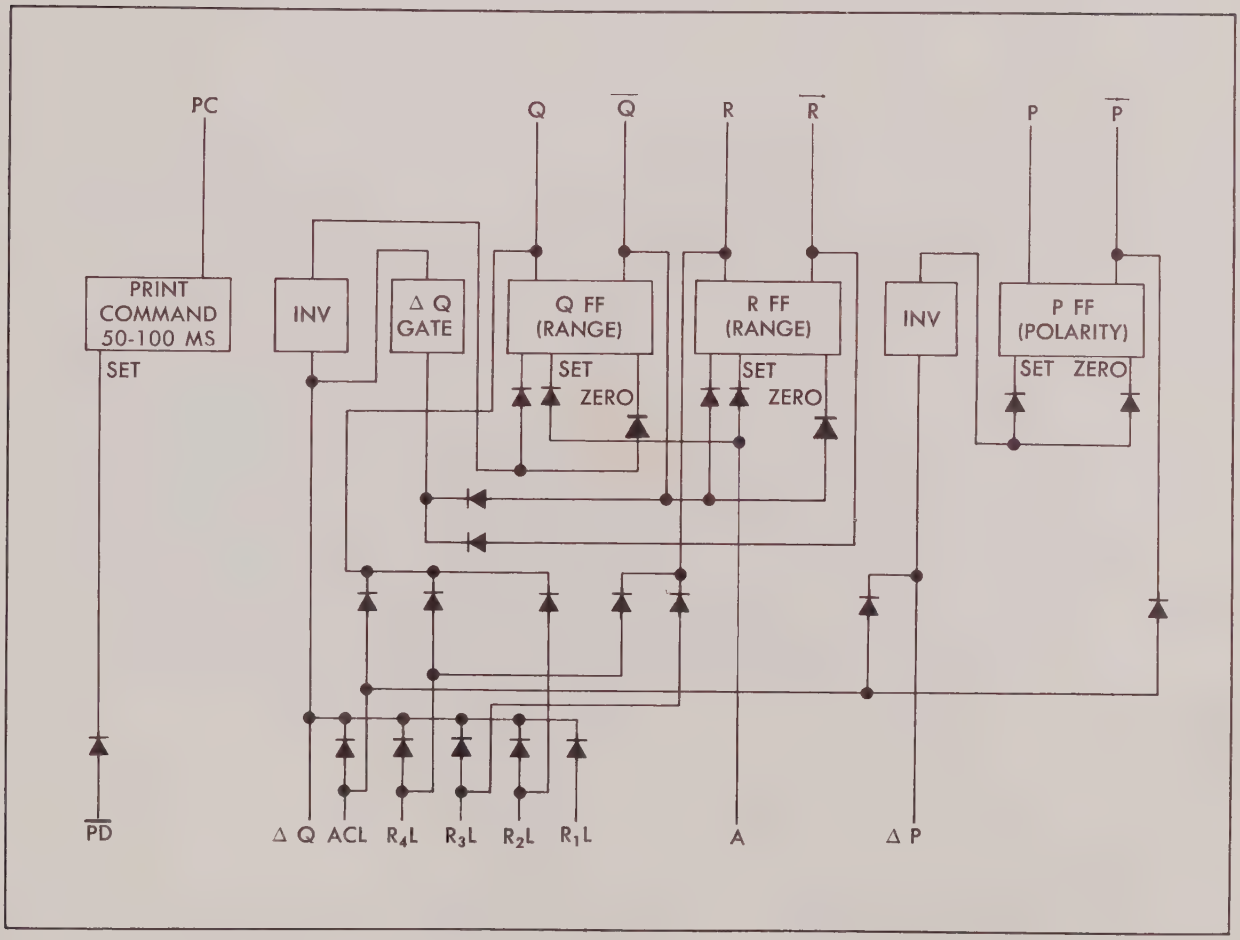


Figure 4-14 C Board Block Diagram

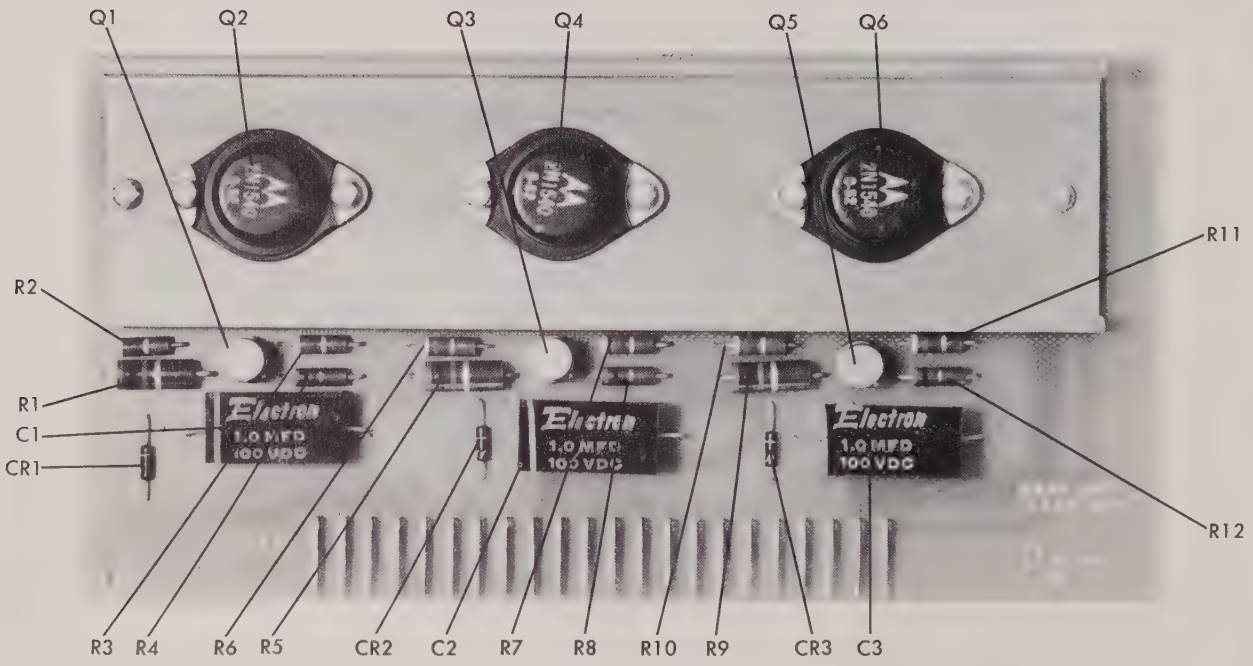


Figure 4-15 D Board Parts Identification

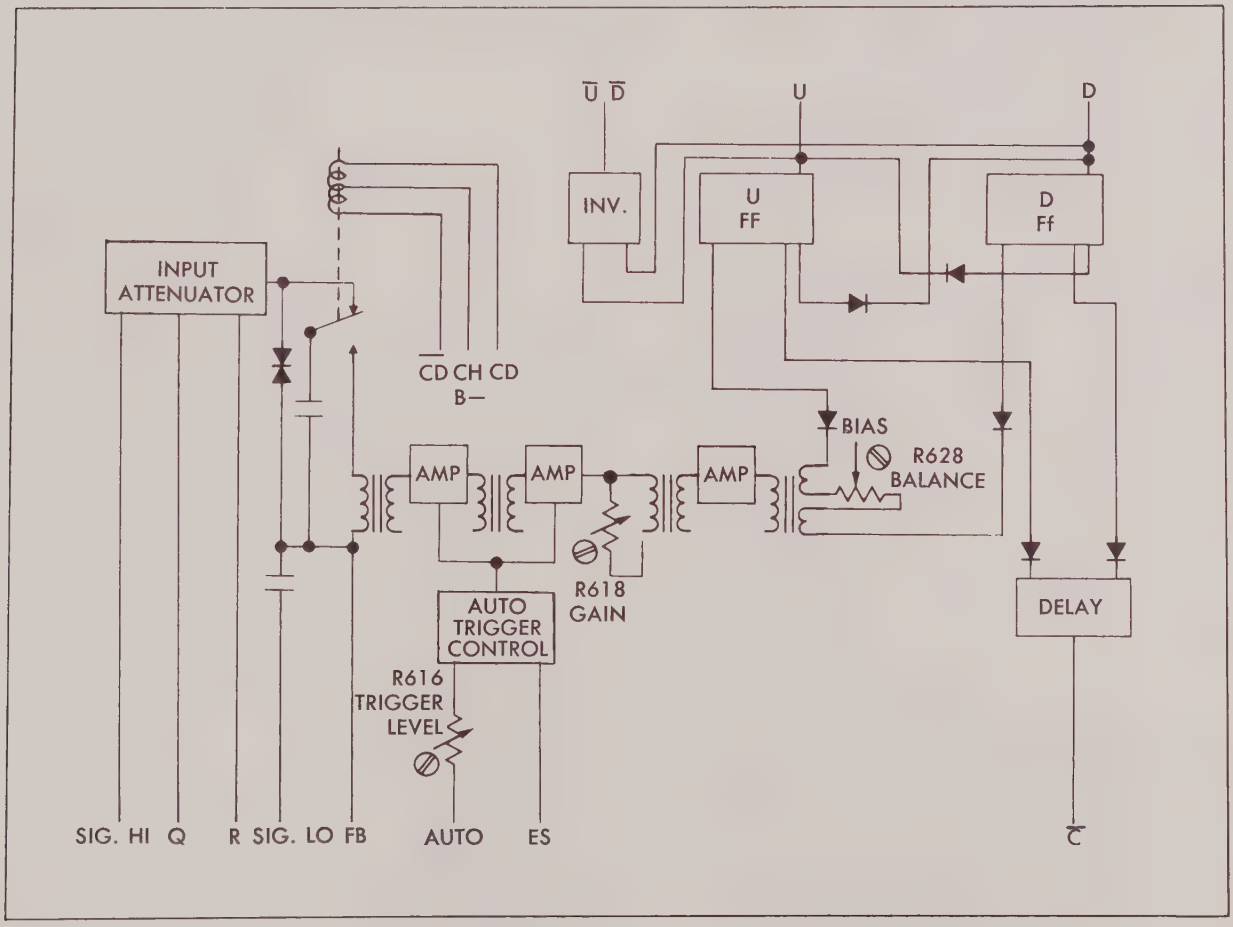


Figure 4-16 Error Amplifier Block Diagram

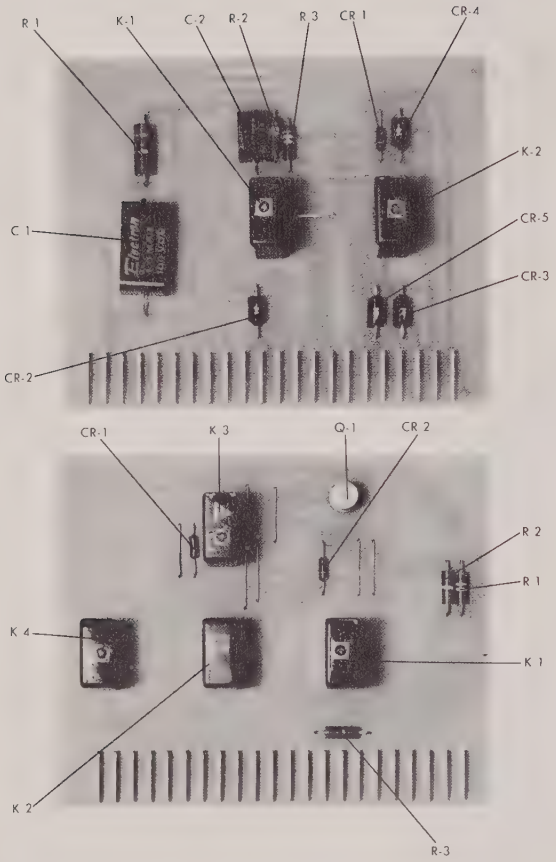


Figure 4-17 Two-relay and Four-relay Boards

bridge circuit compensates for the dynamic impedance of the zener diodes. A full-wave rectifier and filter are incorporated to supply DC to the zener oven heater. The polarity relay, the binary coded calibrating resistors, and the calibrating potentiometer R-810 are also located on this board. R-804 controls the current to the bridge and R-810 is adjusted to compensate for the dynamic resistance of the particular zeners used. R-804 and R-810 are set at the factory and normally should not require adjustment unless the zener diodes are changed. These potentiometers are *not* calibrating adjustments.

XI. RELAY BOARDS

Two relay boards are shown in Figure 4-17 and are titled "Range & Polarity" and "Function AC/DC." These boards provide means for supplying range, polarity, and function information to the readout and printer, as well as providing remote control of these items. A block diagram for these boards is impractical. For further information, consult the simplified schematic in Figure 5-10 of the Maintenance section.

XII. DECIMAL CHECK BOARD

The decimal check board shown here in Figure 4-18 and shown schematically on 11420-860, sheet 2, at the end of the manual, causes the DVM to recycle automatically if an incorrect range selection is made. Due to the nature of the scan logic used in the V34A and V35A, a disturbance in the signal source, after a scan has been initiated, may cause the DVM to up-range erroneously (e.g., 07.634). Although balance has been achieved, and the answer is correct, resolution is lost by a factor of 10. When in the DC AUTO mode, the circuitry causes the DVM to recycle if a zero appears in the most significant decade and the decimal is *not* at LD4. The removal of this board has no effect upon the normal operation of the instrument except for the above described function.

XIII. POWER SUPPLY

The power transformer, as shown on both main board schematics, has two secondary windings. One winding supplies voltage to the zener reference supply and the other provides voltage for the four remaining supplies:

1. Zener oven
2. Negative 15 volts
3. B negative
4. B positive

CR-801, CR-802, and C-801 are on the zener reference

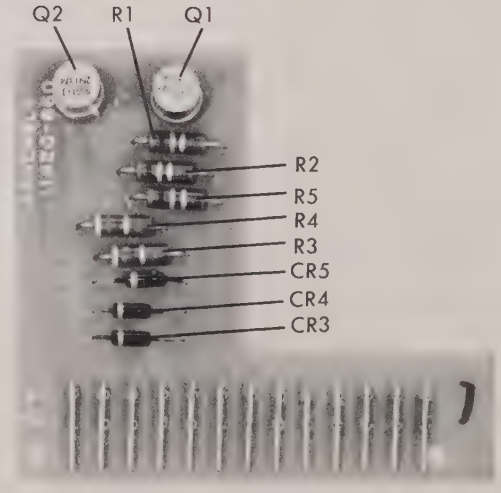


Figure 4-18 Decimal Check Board

board and provide rectified DC for the —15-volt and B— supplies. C-103 provides filtering for the —15-volt supply, and L-101 along with C-106 provide isolation and additional filtering for B— (approximately —12.5 volts). The foregoing are all conventional unregulated supplies. CR-107 and CR-108 together with C-104, R-112, and C-105 provide a filtered B+ voltage which is regulated to a nominal +8 VDC by CR-109.

Section V

MAINTENANCE

This section presents maintenance information from two points of view—the plug-in substitution method, Part I, and the trouble-shooting approach, Parts II, III, and IV.

I. PLUG-IN SUBSTITUTION

Except for the power supply, all of the circuit components are assembled on plug-in boards. Thus the maintenance problems on this complex instrument are simplified to the point where the instrument can be kept operating without the need for highly trained maintenance personnel. Certain other maintenance advantages accrue because of the plug-in design:

- Down time is held to a minimum; the DVM can be kept operating under conditions where it would be impractical or inconvenient to return the instrument to a repair facility or to the manufacturer.
- The complexity of the DVM poses no problem, either to the semiskilled worker or to the trained engineer, since there is no need to troubleshoot, as such, beyond the simple search for a defective plug-in unit.
- The defective plug-in unit can be easily located without a detailed study of symptoms. Only a very few minutes are needed to replace all of the plug-in components. Thus by using the trial-and-error method the DVM can be made to function properly.
- The need for testing equipment is eliminated if a small, space-saving kit (see Section 6) of spares is kept at hand.

Rather than to rely solely upon the trial-and-error method of plug-in replacement, the user can speedily detect the defective plug-in component by following the symptomatic approach:

PLUG-IN COMPONENT FAILURE	SYMPTOMS
A Board	Meter fails to scan—No timing pulses. Meter scans but digits will not change.
B Board	Meter fails to scan—End-of-scan flip-flop not working properly. Meter fails to scan—Transfer switch drive circuitry bad. Meter will not stop scanning in STANDBY. Decade 1 "rolls." Some or all of the decades go to 9's.
C Board	Meter will work on one polarity only. Meter ranges improperly. No print command.
D Boards (2 used)	Meter fails to scan—one of the power amplifiers inoperative.
Range & Polarity Board; Function DC/AC Boards. (Since these boards have closely interrelated functions, they are best viewed as one board for troubleshooting purposes.)	Polarity and/or decimal readout and/or printer presentation incorrect. Function and/or range controls (front panel or remote) do not control DVM properly.
Decimal Check Board	DVM occasionally reads incorrect decimal (e.g., 08.657).
Amplifier Board	Readings erratic. Meter o.k. in one range but not in another (range relays). Offset in low range but not in second range. Malfunction at very high voltages (range relays). Meter drifts on ranges other than lowest range.
Zener Reference Supply	Meter drifts out of specification. +, —, offset. Meter goes to all 9's, both polarities.

PLUG-IN COMPONENT FAILURE	SYMPTOMS
Polarity Relay	Meter o.k. on one polarity, but goes to all 9's on other polarity. +, −, offset (contact resistance).
Decade Switch Assemblies (5 used)	Meter fails to scan—open coil. Meter o.k. some readings—N.G. others.
Transfer Switch	Readings erratic. Meter fails to scan—open coil. Malfunction every 3rd, 6th, 9th, etc., scan or 2 out of 3 scans.

II. MAIN POWER SUPPLY

The V34A and V35A power supplies are the only main portions of the instrument which are not of plug-in design. The relatively large physical size of the power supply components, coupled with the virtually trouble-free design, make plug-in replacement unnecessary. Figure 5-1 shows the position of the power supply as seen from the bottom of the instrument. In general, the power supply is of conventional design. It should be noted, however, that the DC output is not at all pure; do not expect the power supply to provide a battery-like absence

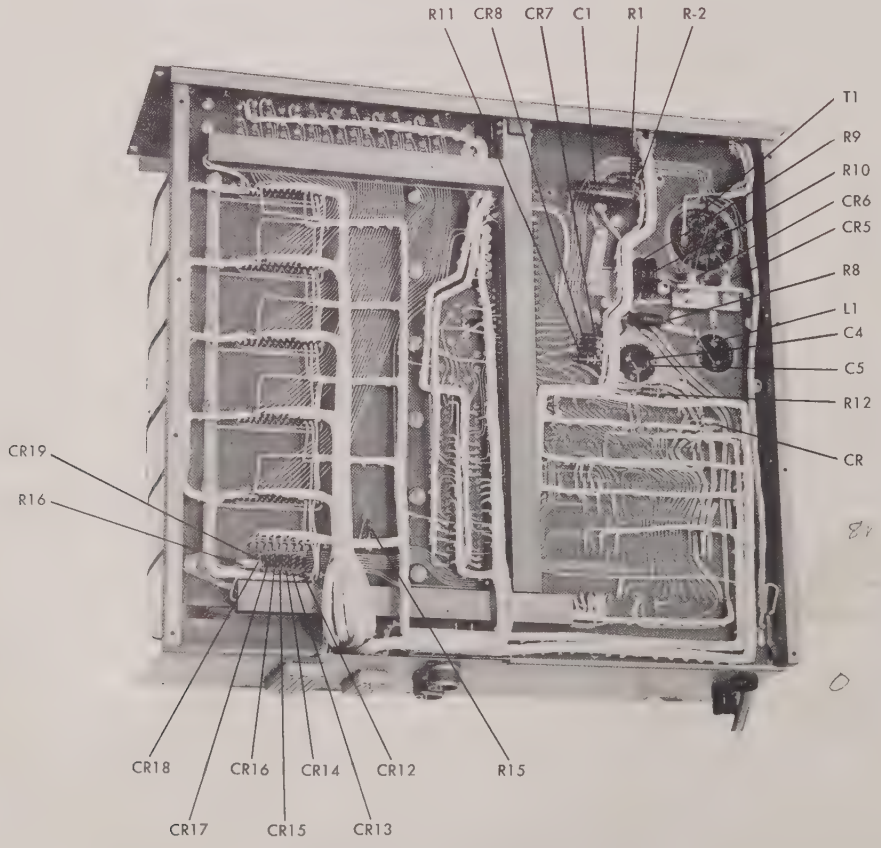


Figure 5-1A Bottom View of Instrument Serial No. 11.3810 & on

of peaks when measured upon an oscilloscope. The V34A and V35A are designed to work without the need for pure, or even nearly pure, DC..

If the power supply is to be checked for output, the following voltage chart will serve as a guide:

NOTE

All measurements are made with the power source at 115 VAC. Any good 20,000 ohm-per-volt meter may be used. Readings taken with this chart as a guide should be accurate ±10%.

DC MEASUREMENTS:

B— Supply	B+ Supply	—15V Supply	Oven Supply Oven Off	Oven Supply Oven On	Mode Switch Setting
—12.5	+8.1	—15.2	+19.3	+15.8	STANDBY
—12.5	+8.1	—15.1	+19.3	+15.8	CONTINUOUS (input leads shorted)

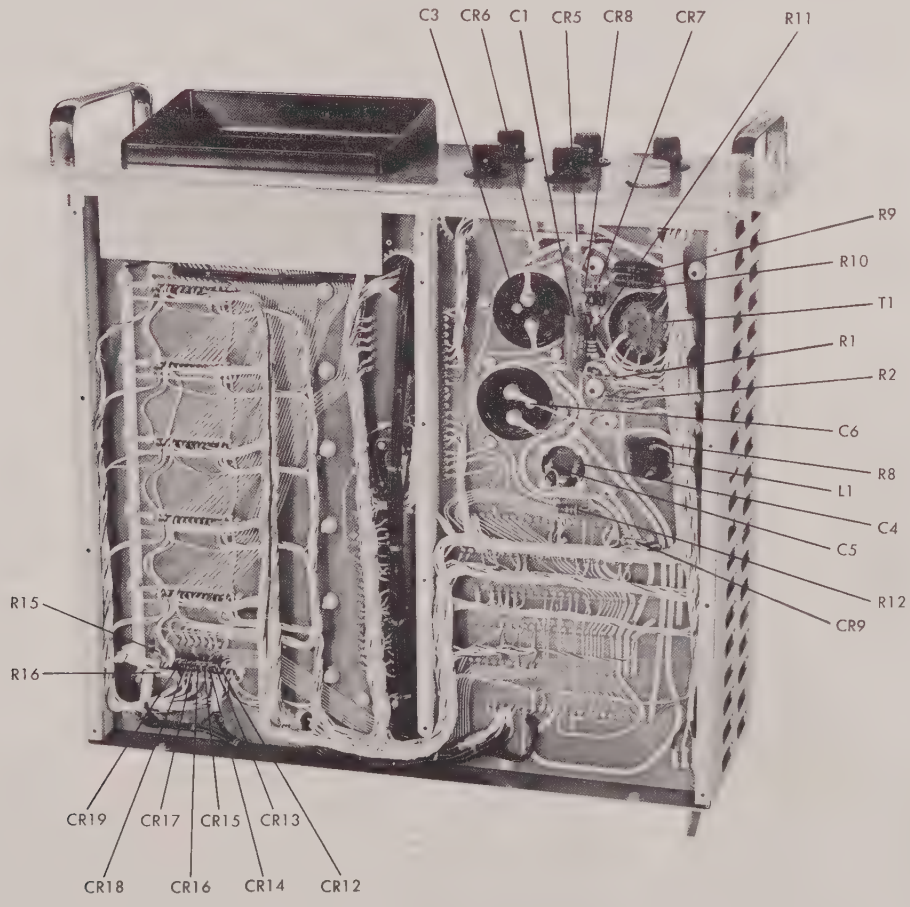


Figure 5-1B Bottom View of Instrument through Serial No. 11.3809

AC MEASUREMENTS: Set oscilloscope for peak-to-peak volts.

B— Supply	B+ Supply	—15V Supply	Oven Supply Oven Off	Oven On	Mode Switch Setting
.03	.02	1.0	.001	3.0	STANDBY
1.0	0.3	2.8	.001	3.0	CONTINUOUS (input leads shorted)

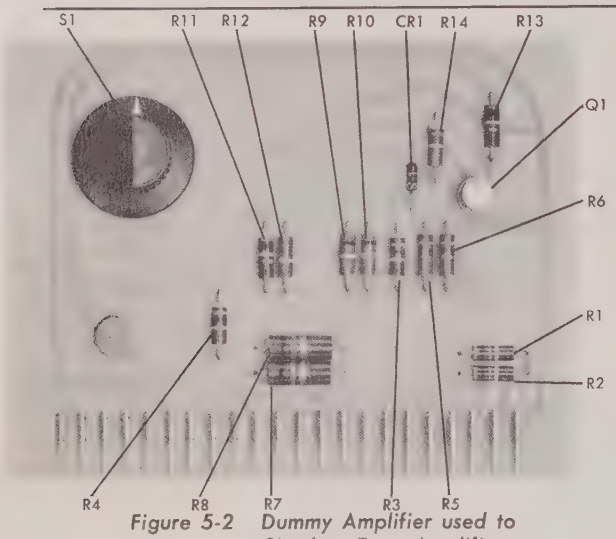


Figure 5-2 *Dummy Amplifier used to Simulate Error Amplifier*

III. LOGIC CHECKOUT USING DUMMY AMPLIFIER

The Dummy Amplifier, shown in Figure 5-2 (Part No. 3017-024), provides a simple means of checking out all of the logic circuits in either the V34A or V35A. The dummy amplifier simulates the amplifier plug-in assembly. It provides proper loading resistors and output pulses. Either an UP (U), DOWN (D), or NO UP or DOWN ($\overline{U}\overline{D}$) pulse may be selected by a switch. The test procedure which follows provides a quick method to assure that all of the logic circuits are functioning properly as well as providing a simple means for locating any malfunctioning assembly.

The Dummy Amplifier, along with its extension board, is substituted for the actual amplifier board when the tests described in this section are made.

For the following tests the FUNCTION switch should be in the VDC position. The MODE switch should normally be in the STANDBY position. Scans should be initiated by moving it to SINGLE SCAN. The POWER switch is in the ON position.

The front panel controls should be checked out first: *Mode Switch*—In STANDBY, the meter should not scan in any dummy amplifier switch position. Moving to SINGLE SCAN should cause one scan only. Another scan may be initiated by moving to STANDBY and returning to SINGLE SCAN.

In AUTO the meter should scan continuously when the dummy amplifier is in either U or D, but should not scan when the dummy amplifier is in $\overline{U}\overline{D}$. In CONTINUOUS the meter should scan continuously for all three positions of the dummy amplifier.

Power Switch—Turn the POWER switch to PRINT and the MODE switch to CONTINUOUS. The meter should scan once, and lock up. The print command relay should be heard operating momentarily at the end of scan. Momentarily returning the POWER switch to ON should initiate another scan.

With the dummy amplifier set to $\overline{U}\overline{D}$, set the POWER switch to AUTO PRINT and the MODE switch to CONTINUOUS; the DVM should behave exactly as described with the POWER switch set to PRINT. First set the dummy amplifier to U, then set DVM controls as above; the DVM should continuously recycle until the dummy amplifier is returned to $\overline{U}\overline{D}$, at which time the DVM should lock up at the end of the scan and the print command relay should operate. Repeat the last test with the dummy amplifier initially set to D. Repeat the last two tests with the MODE switch set to AUTO.

Once it is ascertained that the front panel controls are working properly, the scan logic circuits may be checked out. Operate the DVM in VDC and SINGLE SCAN mode.

DUMMY AMPLIFIER	READING V35A	V34A
U	+999.99	+999.9
D	−999.99	−999.9

Repeat several times. All of the lower range decimal lights should flicker at the beginning of each scan. With the reading at +999.99, short ΔP on C board to power ground.

DUMMY AMPLIFIER	READING V35A	V34A
D	+0.0000	+.0000
$\overline{U}\overline{D}$	+9999.0	+999.0
U	+9999.9	+999.9

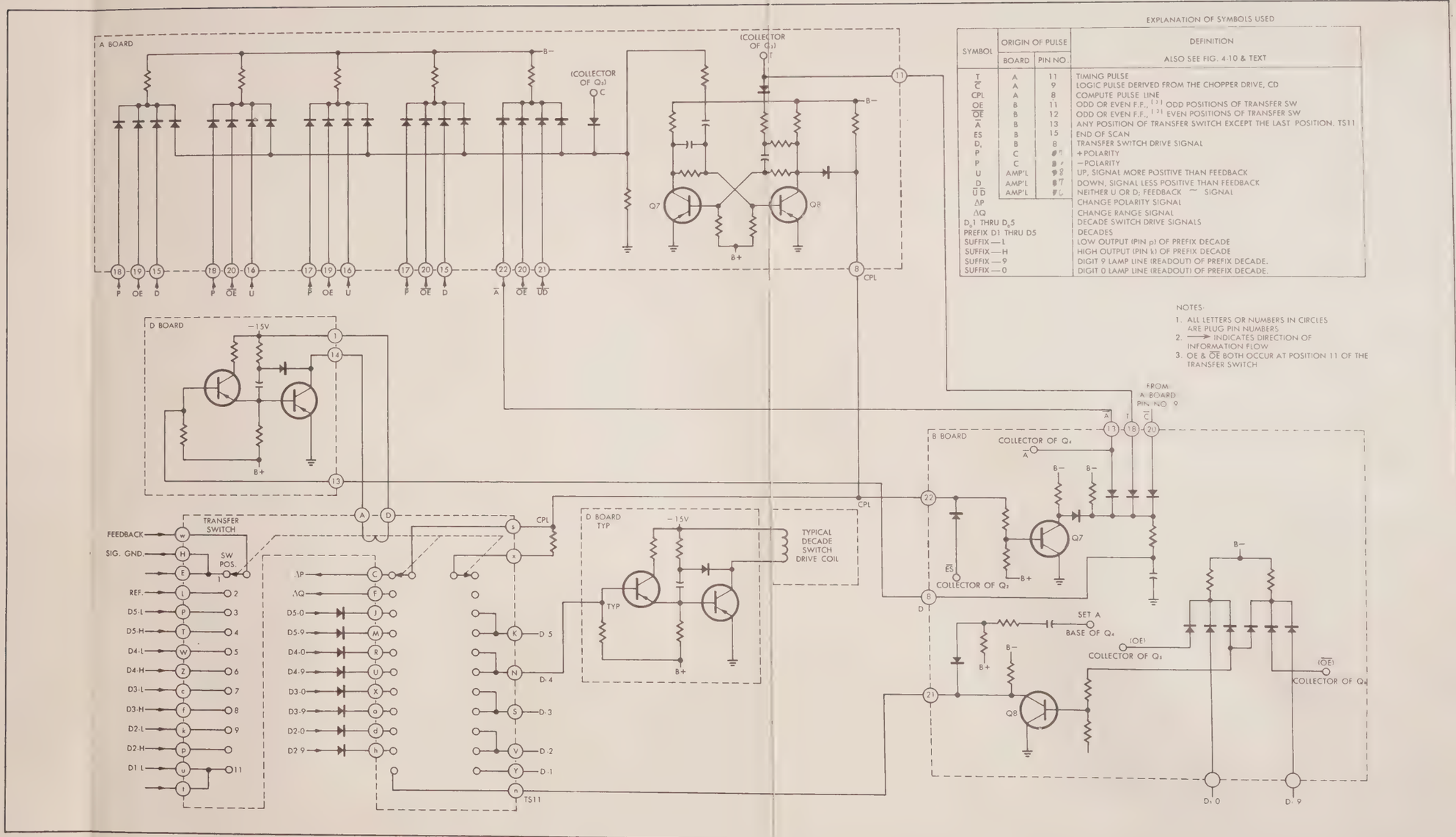


Figure 5-3 Simplified Schematic of Logic Circuits

Repeat the sequence several times. The lower range lights should flicker for U and $\overline{U}\overline{D}$. Remove the ΔP to ground short. Set the dummy amplifier to D and scan once, producing a reading of —999.99. Short ΔP to ground.

DUMMY AMPLIFIER	READING V35A	V34A
U	—0.0000	—.0000
$\overline{U}\overline{D}$	—999.90	—999.0
D	—999.99	—999.9

Repeat the sequence several times. Remove the ΔP to ground short. The logic checkout is complete.

If scan errors occur 1 out of 3, 2 out of 3, 1 out of 6, etc., the trouble is a stepping switch. If errors occur in one polarity but not in the other, the A Board is bad. If polarity doesn't change properly or if the meter doesn't range properly, the C Board is faulty. If the meter "rolls" continuously in any decade but Decade 1, one of the "0" or "9" light diodes located on the main board under the transfer switch is bad. If Decade 1 rolls continuously, the B Board is bad. If 0's appear instead of 9's, or 9's instead of 0's, the fault is most likely to be the B Board.

A survey of the plug-in symptom chart in Part I of this section will reveal that many plug-in units can cause scan failure. Failure to scan will always show up in the logic checkout. Figure 5-3 is a simplified schematic of the Compute Pulse Line (CPL) and its associated circuitry. This diagram can be of considerable assistance in tracing the faulty plug-in assembly.

Connect an oscilloscope from CPL (Pin 22 on the B Board) to power ground (Pin 3 on the B Board). If a pulse similar to that pictured in Figure 4-10 exists, then a Compute Pulse (CP) exists. Using Figure 5-3 as a guide, trace CPL through the transfer switch to ΔP, ΔQ, or one of the decade drives. If CP exists on ΔP or ΔQ, the C Board is at fault. If CP exists on one of the decade drives, the trouble is either the appropriate D Board or decade switch. A CP on one of the decade drives will fall to about —0.3 volt, instead of —6 volts as on CPL. If a CP does not exist ($\overline{CP}$), the transfer switch should be stepping. Connect the oscilloscope to D_T (pin on the B Board). This point should show a pulse from approximately +8 volts to —0.3 volt. If the pulse exists, the fault is either the appropriate D Board or the transfer switch. If the pulse does not exist, the fault is most likely to be the B Board.

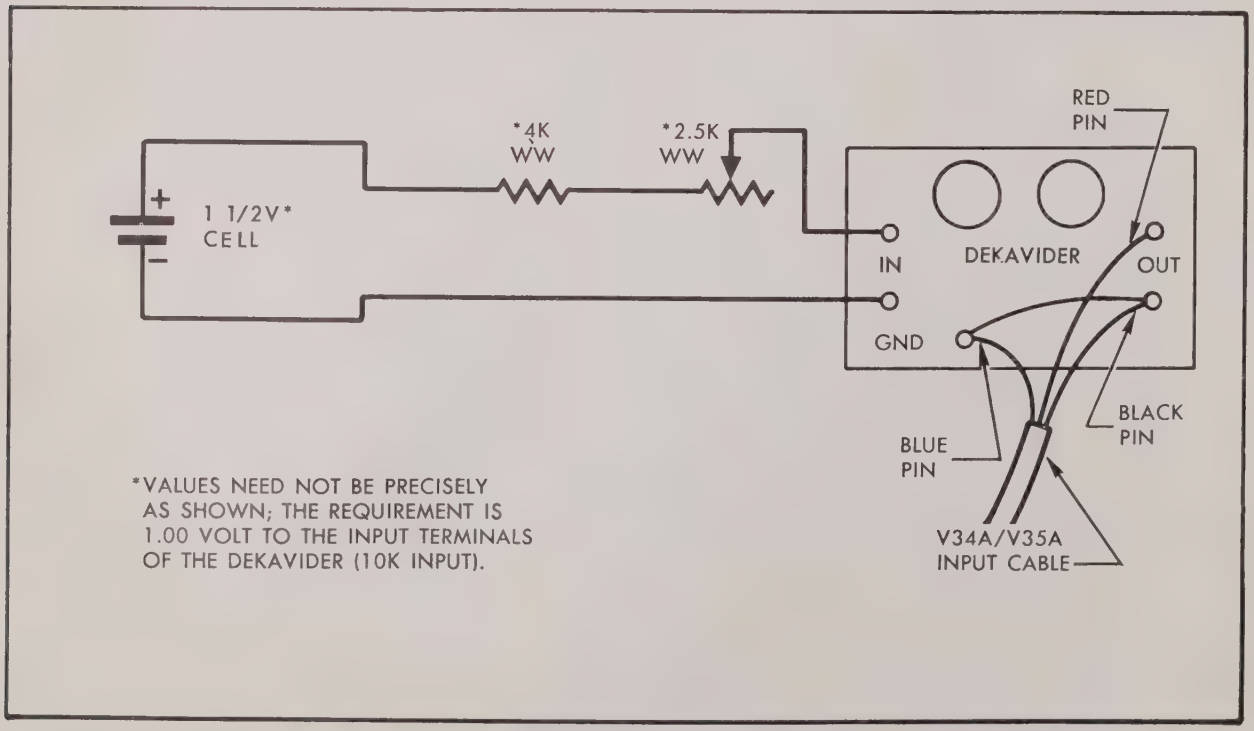


Figure 5-4 Voltage Source and Amplifier Input

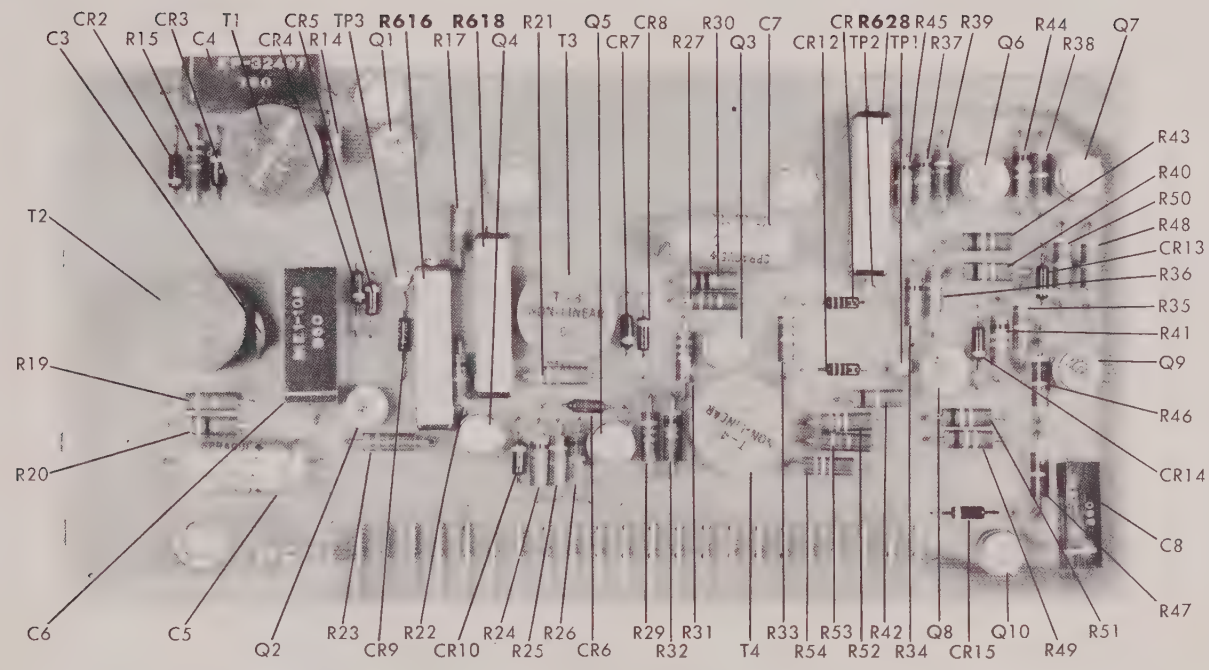


Figure 5-5 Error Amplifier, Showing Test Points, Adjustments, and Parts Identification

Satisfactory completion of the logic test assures that the following assemblies are functioning properly:

A Board
B Board
C Board
D Boards
Transfer Switch (logic levels only)

IV. Non-Logic Malfunctions

Non-logic malfunctions are limited to zener reference supply, Kelvin-Varley divider circuits (including one level of the transfer switch), the polarity relay, and the amplifier assembly. Malfunctions of this type are most easily corrected by plug-in assembly substitutions. The plug-in symptom chart in Part I of this section may be used as a guide. The following list is arranged in increasing order of failure probability:

Range Relays
Amplifier Assembly, Proper
Transfer Switch
Chopper
Decade Switch
Zener Reference Supply

NOTE

+, −, offset is most often caused by power plug reversal (see Section II, Part I). It is seldom that the cause is actually a faulty component. Improper connection to a remote printer may be the cause of offset.

V. Amplifier Tests and Adjustments

The procedure for making gain and balance adjustments and signal-to-noise ratio measurements is here described. Figures 5-5 and 5-6 show the amplifier.

NOTE

No amplifier adjustments should be made unless it has been determined that all other portions of the DVM are functioning properly.

To test and adjust the amplifier, the following items, or their equivalents, will be required:

1. Oscilloscope, Tektronix 533.
2. Dekavider, Model DV-411.
3. Voltage source, as shown in Figure 5-4.

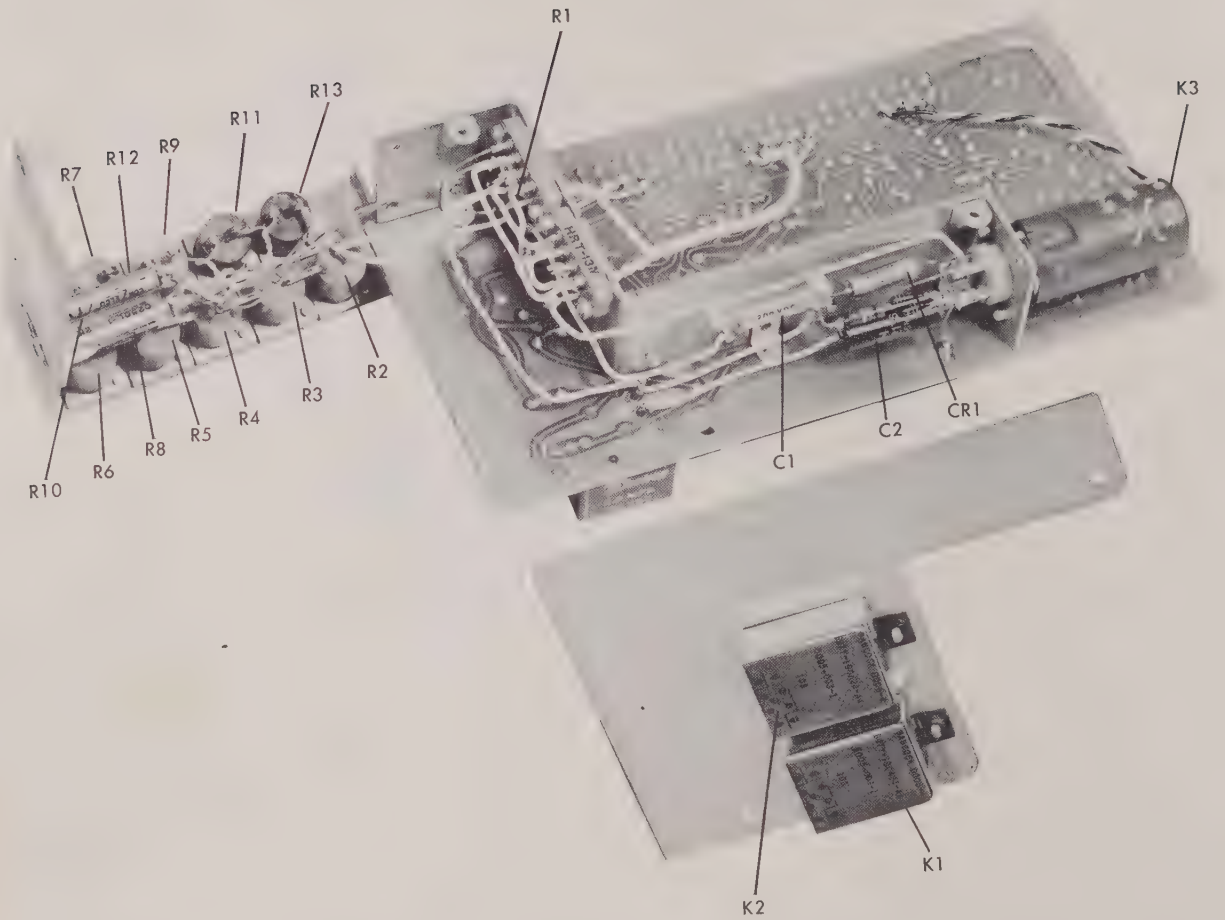


Figure 5-6 Error Amplifier, Showing Shield Assembly Partially Disassembled

Procedure:

a. Connect oscilloscope to amplifier as follows: (see Figure 5-5)
   1. Ground to Pin 1.
   2. Input to TP-1.
   3. Trigger to Pin 3.

b. On the amplifier board, clip TP-3 to Pin 1. Set the voltage source to +.00050 volt and flip the MODE switch to the SINGLE SCAN position one time. The readout should display +0.0005 ±1 digit in the V35A, or ±.0005 ±1 digit in the V34A.

c. Set the oscilloscope controls as follows:
   1. DC Input.
   2. Sensitivity, 0.2 V/CM (0.02 V/CM with 10:1 probe).
   3. Sweep Rate, 100 microseconds/CM.
   4. Trigger, external +, AC slow.

d. Set voltage source at +.0015 and observe large pulse on oscilloscope face. Center the pulse upon the oscilloscope face and expand the sweep by 50. (The pulse is very narrow and difficult to see on an oscilloscope not having the bandwidth of the Type 533.)

e. Return the voltage source to +.00050 and slowly vary the Dekavider 1/10,000 dial to obtain an absolute minimum pulse. Record the reading. The difference between the new Dekavider setting and .00050 is the offset of the DVM. If the offset is greater than .00004

(the average is .000025), there is excessive leakage or AC pickup in the signal or feedback. Correct this trouble, if it occurs, before going ahead with the amplifier adjustments.

f. Recheck the null point and proceed as follows:

1. Set the Dekavider to a reading which is .00005 less than the null reading just checked.
   Example: If null reading is .00048, the Dekavider setting will be .00043.
2. If a steady square wave (leading edge at the same point as the error pulse) now appears, rotate R-618 CCW (counterclockwise) until the square wave just starts to "blip;" if no square wave is present, rotate R-618 CW until a steady square wave appears, then CCW until the square wave just starts to "blip."
3. Clip the oscilloscope input to TP-2 and set the Dekavider to a reading .00005 more than the null reading.
   Example: If null reading is .00048, the Dekavider setting will be .00053.
4. If a steady square wave appears, rotate the balance control R-628 CW until the square wave just starts to "blip;" then return R-628 CCW one half the turns to the initial setting. If the square wave is "blipping" initially, rotate R-628 CCW until the same degree of "blipping" is present as in Step 2; then return R-628 CW one half the turns to the initial setting. The balance potentiometer should now be balanced and will need only slight readjustment in the recheck to follow.
5. It is important to notice if the amplitude of the square wave is approximately (within 20%) the same for Steps 2 and 4; if the amplitude of Step 2 is less, Q-606 is probably weak; if the amplitude of Step 4 is less, Q-608 is probably weak. Recheck Steps 1 through 4.
6. When recheck is complete, and with the settings as called out at the completion of Step 4, rotate R-618 slightly CW until the "blipping" just stops. Reduce the error of Step 3 to +.000035 (Dekavider setting of .000515 if null has remained constant). The square wave should be completely gone (no blips). If the preceding steps have been done correctly and the square wave appears, it can be assumed that the amplifier is excessively noisy and requires repair.
7. With the setting maintained as in Step 6, but with the oscilloscope input connected to TP-1, observe the signal-to-noise ratio. The observed ratio should never be less than 3:1; a typical amplifier is 4:1. See Figure 5-7 for typical output wave form.

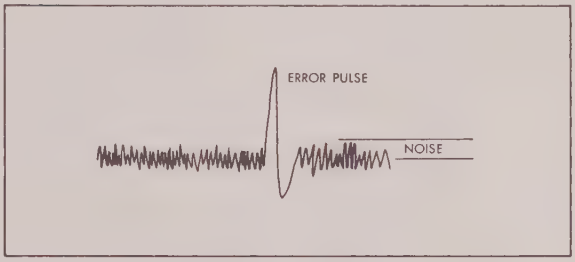


Figure 5-7 Error Amplifier Output Wave Form

VI. ZENER REFERENCE VOLTAGE SUPPLY

The V34A and V35A zener reference supply is a plug-in unit containing all the elements required to furnish a calibrated ±10.000 VDC to the feedback voltage divider. As discussed in the Calibration Section, the only calibration adjustment is R-810 which is set after the correct jumper connections are made. All other adjustments have been made at the factory and should *not be touched* unless it is necessary to replace components. Because of the techniques involved, it is recommended that this unit be returned to the factory for repair and readjustment.

When calibrating R-810, it is possible (due to different standards to which the DVM may be calibrated) that R-810 will reach its limit before calibration is achieved. This is much more likely to occur with the V34A than the V35A since R-810 covers a range of 120 digits for the V35A and only 12 digits for the V34A, with an overlap of 20% in both cases (24 digits for the V35A and 2.4 digits for the V34A). If R-810 has been rotated fully clockwise, change the jumpers to those called out on the line above the initial jumper connections as shown in Figure 5-8. If R-810 is fully counterclockwise, change the jumpers to those called out on the line below the initial jumper connections.

When it is necessary to service this unit in the field, an extension board from the service and spares kit should be used to make the test points accessible. Schematic 11420-050, Sheet 2; Figure 5-8; and Figure 5-9 should be consulted as guides when making tests. Do not replace any parts or make any adjustments until the following tests have been made:

a. The voltage as measured from TP− to TP+ should be 7.7 VDC with the line voltage at 115 VAC. When

RANGE OF R-810 VOLTS	JUMPERS
12.682 - 12.670	
.672 - .660	1-2
.662 - .650	2-3
.652 - .640	1-3
.642 - .630	3-4
.632 - .620	3-4, 1-2
.622 - .610	2-4
.612 - .600	1-4
.602 - .590	4-5
.592 - .580	4-5, 1-2
.582 - .570	4-5, 2-3
.572 - .560	4-5, 1-3
.562 - .550	3-5
.552 - .540	3-5, 1-2
.542 - .530	2-5
.532 - .520	1-5
.522 - .510	5-6
.512 - .500	5-6, 1-2
.502 - .490	5-6, 2-3
.492 - .480	5 6, 1-3
.482 - .470	5-6, 3-4
.472 - .460	5-6, 3-4, 1-2
.462 - .450	5-6, 2-4
.452 - .440	5-6, 1-4
.442 - .430	4-6
.432 - .420	4-6, 1-2
.422 - .410	4-6, 2-3
.412 - .400	4-6, 1-3
.402 - .390	3-6
.392 - .380	3-6, 1-2
.382 - .370	2-6
.372 - .360	1-6
.362 - .350	6-7
.352 - .340	6-7, 1-2
.342 - .330	6-7, 2-3
.332 - .320	6-7, 1-3
.322 - .310	6-7, 3-4
.312 - .300	6-7, 1-2, 3-4
.302 - .290	6-7, 2-4
.292 - .280	6-7, 1-4
.282 - .270	6-7, 4-5
.272 - .260	6-7, 4-5, 1-2
.262 - .250	6-7, 4-5, 2-3
.252 - .240	6-7, 4-5, 1-3
.242 - .230	6-7, 3-5
.232 - .220	6-7, 3-5, 1-2
.222 - .210	6-7, 2-5
.212 - .200	6-7, 1-5
.202 - .190	5-7
.192 - .180	5-7, 1-2
.182 - .170	5-7, 2-3
.172 - .160	5-7, 1-3
.162 - .150	5-7, 3-4
.152 - .140	5-7, 3-4, 1-2
.142 - .130	5-7, 2-4
.132 - .120	5-7, 1-4
.122 - .110	4-7
.112 - .100	4-7, 1-2
.102 - .090	4-7, 2-3
.092 - .080	4-7, 1-3
.082 - .070	3-7
.072 - .060	3-7, 1-2
.062 - .050	2-7

RANGE OF R-810 VOLTS	JUMPERS
12.052 - 12.040	1-7
.042 - .030	7-8
.032 - .020	7-8, 1-2
.022 - .010	7-8, 2-3
.012 - 12.000	7-8, 1-3
.002 - 11.990	7-8, 3-4
11.992 - .980	7-8, 3-4, 1-2
.982 - .970	7-8, 2-4
.972 - .960	7-8, 1-4
.962 - .950	7-8, 4-5
.952 - .940	7-8, 4-5, 1-2
.942 - .930	7-8, 4-5, 2-3
.932 - .920	7-8, 4-5, 1-3
.922 - .910	7-8, 3-5
.912 - .900	7-8, 3-5, 1-2
.902 - .890	7-8, 2-5
.892 - .880	7-8, 1-5
.882 - .870	7-8, 5-6
.872 - .860	7-8, 5-6, 1-2
.862 - .850	7-8, 5-6, 2-3
.852 - .840	7-8, 5-6, 1-3
.842 - .830	7-8, 5-6, 3-4
.832 - .820	7-8, 5-6, 3-4, 1-2
.822 - .910	7-8, 5-6, 2-4
.812 - .800	7-8, 5-6, 1-4
.802 - .790	7-8, 4-6
.792 - .780	7-8, 4-6, 1-2
.782 - .770	7-8, 4-6, 2-3
.772 - .760	7-8, 4-6, 1-3
.762 - .750	7-8, 3-6
.752 - .740	7-8, 3-6, 1-2
.742 - .730	7-8, 2-6
.732 - .720	7-8, 1-6
.722 - .710	6-8
.712 - .700	6-8, 1-2
.702 - .690	6-8, 2-3
.692 - .680	6-8, 1-3
.682 - .670	6-8, 3-4
.672 - .660	6-8, 3-4, 1-2
.662 - .650	6-8, 2-4
.652 - .640	6-8, 1-4
.642 - .630	6-8, 4-5
.632 - .620	6-8, 4-5, 1-2
.622 - .610	6-8, 4-5, 2-3
.612 - .600	6-8, 4-5, 1-3
.602 - .590	6-8, 3-5
.592 - .580	6-8, 3-5, 1-2
.582 - .570	6-8, 2-5
.572 - .560	6-8, 1-5
.562 - .550	5-8
.542 - .530	5-8, 2-3
.532 - .520	5-8, 1-3
.522 - .510	5-8, 3-4
.512 - .500	5-8, 3-4, 1-2
.502 - .490	5-8, 2-4
.492 - .480	5-8, 1-4
.482 - .470	4-8
.472 - .460	4-8, 1-2
.462 - .450	4-8, 2-3
.452 - .440	4-8, 1-3
.442 - .430	3-8
.432 - .420	3-8, 1-2
.422 - .410	2-8
.412 - .400	1-8

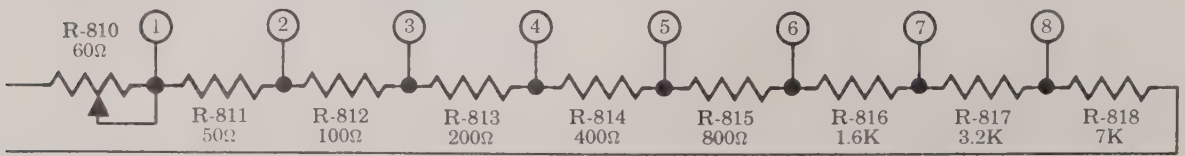


Figure 5-8 Jumper Connections for 10-volt Calibrate Resistors

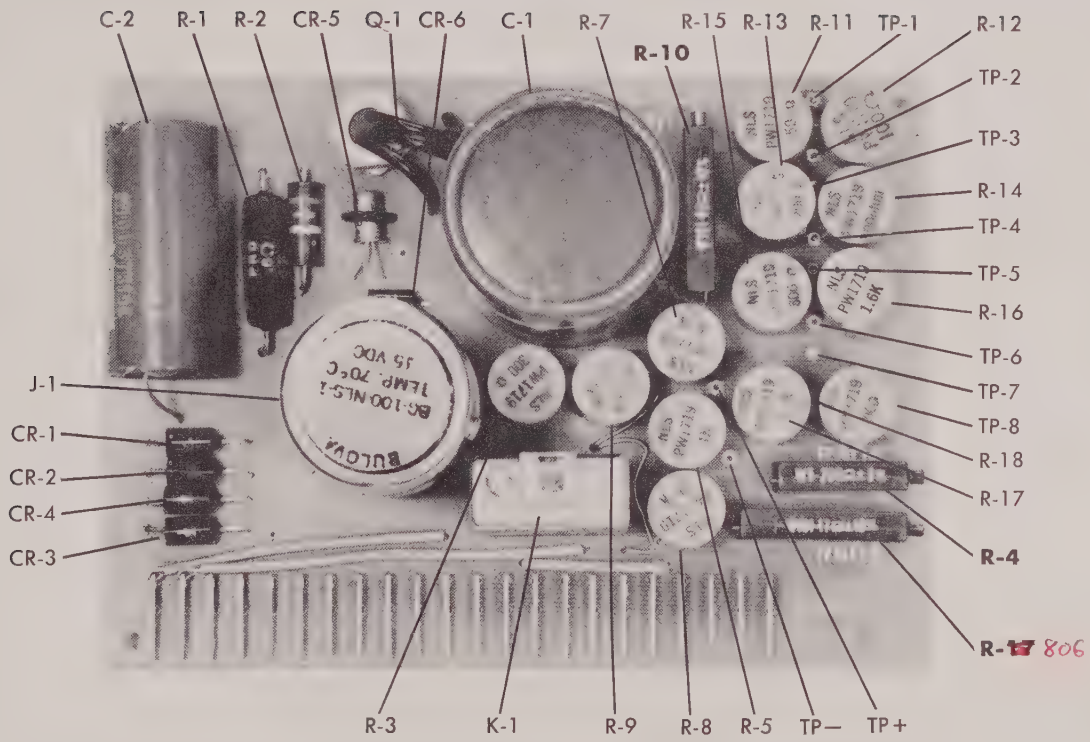


Figure 5-9 Zener Reference Voltage Supply, Showing Test Points, Adjustments, and Parts Identification

the line voltage is varied from 105 VAC to 125 VAC, the regulated DC voltage measured should not vary more than ±0.2%. This measurement must be made with a device having a minimum of 500 K ohms input impedance. If the regulation is within limits and the voltage measured is not 7.7 VDC, adjust R-804 and recheck regulation. If it is impossible to achieve regulation and the correct voltage, measure the voltage across C-802. This voltage should be 36 VDC ±1 volt @ 115 VAC line voltage; if not, check CR-803, CR-804, R-802, and C-802; also check AC supply to Pins 16, 17, and 18. If the voltage is correct (across C-802), the fault is likely to be Q-801; also check CR-805 (6-volt zener), CR-806, and resistors R-803 through R-809. If the voltage from TP+ to TP— is very low or zero, CR-821 is defective or there is an "open" in the associated circuitry.

b. Connect a DC voltmeter across C-801. With the line at 115 VAC, the voltage across C-801 will be 19 VDC ±1 volt with the oven heater HR-821 off (S-821 open). With the heater on, the voltage will be 16 VDC, ±1 volt. Observe this voltage to determine correct operation of HR-821 and S-821.

c. Make up a test network consisting of a 30 K ohm resistor in series with a 1 mfd capacitor. Connect one end of this network to TP+ and the other to Pin 17 of the zener board. Connect the oscilloscope ground (Tektronix 502 or equivalent) to Pin 6 and the input to Pin 5 (the oscilloscope must be isolated from ground). With the DVM in positive polarity and at

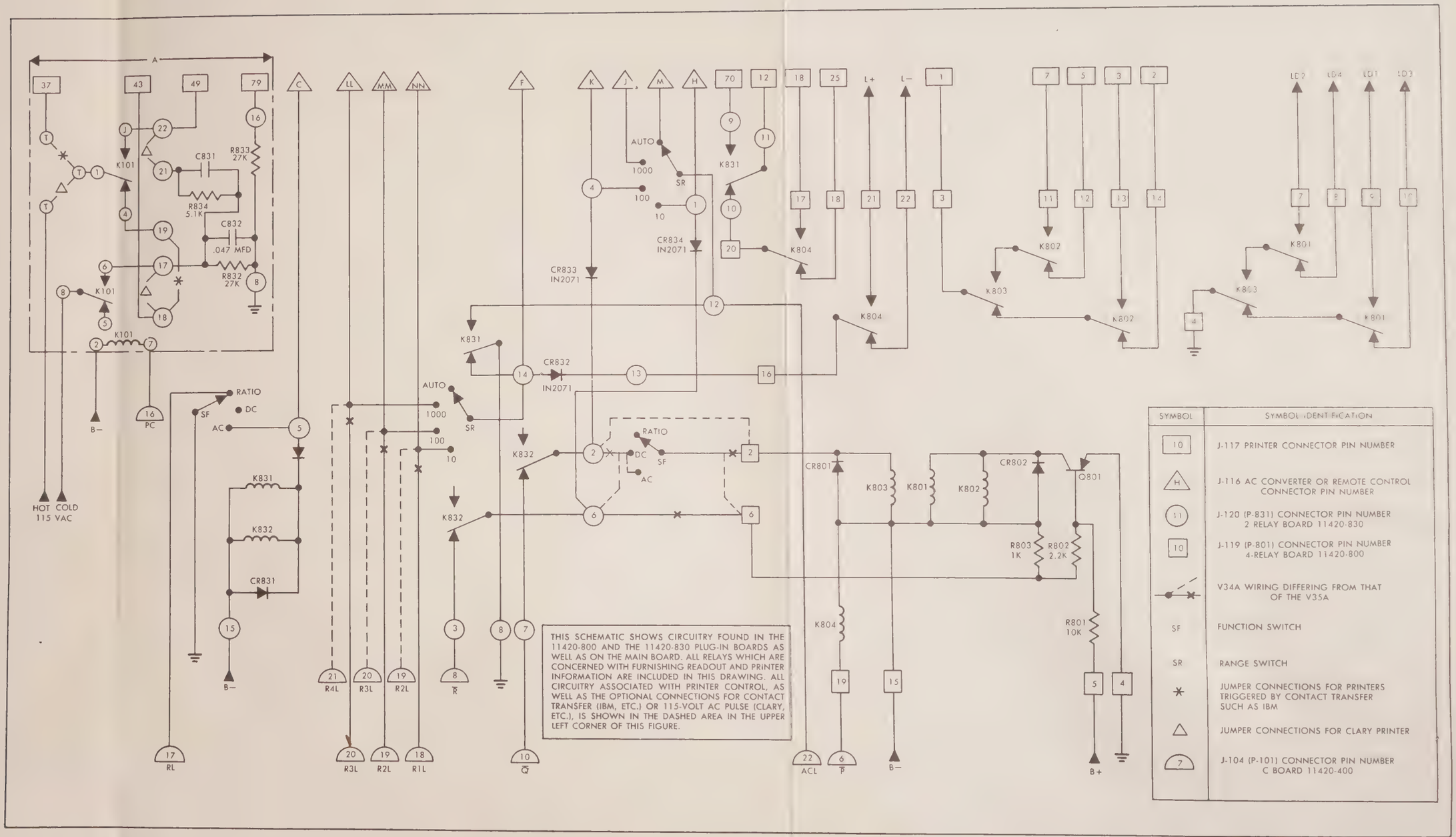


Figure 5-10 Simplified Schematic — Range and Function Control

balance with a very low reading (e.g., 0.0005), adjust R-806 for minimum AC ripple as seen on the scope. Typically, this ripple will be less than 1 millivolt when R-806 is properly adjusted. With the test network removed, the ripple should be less than 200 microvolts with the DVM at balance (low reading) in either polarity.

VII. RANGE AND POLARITY—FUNCTION AC/DC

These boards are schematically shown on Sheet 2 of Drawings 11420-800 and 11420-830, respectively. For an overall understanding of the functions handled by these boards, shown in Figure 4-17, see Figure 5-10. In addition to the function indicated in the title, the 11420-830 board has components and circuitry associated with data printing functions; these components, together with the Print Relay K-101 (located on the main board), are shown in a group in Figure 5-10.

If trouble is encountered in any of the functions associated with the Range and Polarity boards, a study of Figure 5-10 should indicate the probable area of failure. Point-to-point checks for continuity, with the relays in both the energized and de-energized conditions, along with simple ohmmeter tests of diodes, should quickly locate the trouble.

To test the functions of Q-801, K-801 and K-802 (11420-800), ground Pin 4, apply +8 VDC to Pin 5 and −12 VDC to Pin 15; Q-801 should be conducting and K-801 and K-802 should be energized. The grounding of Pin 6 should cut off Q-801, and K-801 and K-802 should be de-energized.

VIII. DIGITAL READOUT MAINTENANCE

The digital readout does not ordinarily require maintenance other than lamp bulb replacement or an occasional cleaning. To remove the readout, proceed as follows:

1. Gently lift the black readout visor and then pull outward. The readout assembly is now exposed and the retaining side brackets may be observed.

2. Spread the two retaining side brackets and gently tilt the readout forward from the top, allowing the bottom to pivot.

3. The readout is now free to continue its travel outward. Be certain to avoid exerting a direct pull; instead, allow the readout to come forward while the pivot points are seated in the pivot slots. At the end of travel, the readout can be readily removed without danger of bending the lamp contact springs.

4. To replace the readout, first engage it at the pivot points. Failure to do so may cause the lamp springs to become bent. It will be necessary to spread aside the retaining end brackets to allow the body of the readout to return to its correct position. When the readout is in place, the retaining end brackets will normally fall into position, locking the readout.

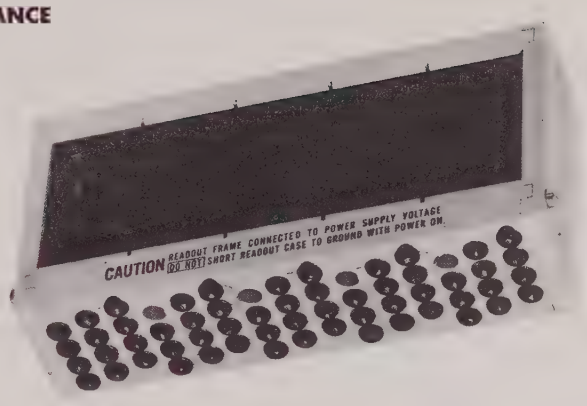


Figure 5-11 Front View of Readout Showing Bulbs Correctly Positioned

Once the readout has been removed, the lamps may be extracted. Prior to replacing any lamps, the contact springs for the bulbs (in the readout receptacle) should be examined. If any are bent down, they should be gently lifted to the level of the others. To locate the proper bulb position, see Figure 5-11 as well as a drawing provided on the main schematic at the end of the manual. Note that this is a diagram of the readout contact board, *not* the readout.

Under extremely adverse dust or humidity conditions, the individual readout plates may require cleaning. If accumulated dust particles are likely to be unusually abrasive, a camel-hair brush or artist's sable brush should first be used to remove loose dust particles. The plates may then be cleaned with commercial isopropyl alcohol and lint-free paper such as Kimwipes 900-L, manufactured by Kimberly-Clark, Neenah, Wisconsin. The individual plates are readily slid out of their grooves by removing either structural end plate from the readout. It is well to be systematic about this operation so as to avoid replacing the plates in improper order. Care should be taken to avoid replacing the plates backwards; this sort of error is most likely to occur with plates marked 1, 0, 6, 8, or 9. Note that the engraved side always faces to the rear of the readout.

The Polaroid filter at the front of the display may be removed and cleaned in the same manner as the readout plates. Care should be taken to reinstall the filter so that the polarizing action is correct. Look through the filter at a piece of shiny metal, such as the chrome rim of a wristwatch. If the metal shows a markedly violet cast, then the filter front is the surface closest to the eye.

Section VI

PARTS LIST

This section lists the parts used with the Model V34A and V35A Digital Voltmeters. Since these instruments rely largely upon plug-in components, the parts listing is broken down to a plug-in level. Circuit references to individual parts are coded according to the dash number of the schematic drawing associated with the board on which the part is used. For example, D Board resistors are all numbered in the 500 series; R-1, in this example, is called out on the drawing as R-501; if, as on the four-relay board assembly drawing, a resistor is called out as R-1, it is understood from the schematic note to really be R-801. In all cases, the parts list drops the hundreds' prefix. All part numbers given are those of the manufacturers.

While any of the parts and components shown may be purchased separately, a spares and service kit has been designed to meet the spares requirements for a quantity of 15 Series 30A instruments. In addition to spares, the kit contains extension boards which raise the plug-in circuit boards to a position which makes access convenient. Also in this kit is a dummy amplifier, shown in Figure 5-2 in the Maintenance Section. Figure 6-1 shows the V34A/V35A Spares and Service Kit.

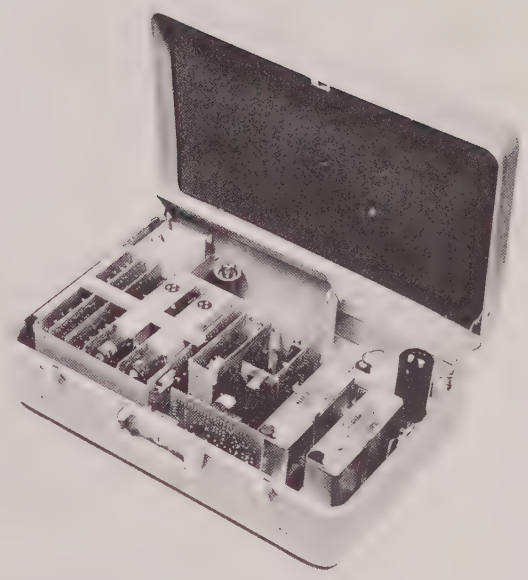


Figure 6-1 Spares and Service Kit for V34A/V35A

Circuit Reference	Part Number	Description	Spares Req'd Per Year For Ten Units	Qty Per Unit	Manufacturer	Not Used In	
						V34A	V35A
	11420-100	—MAIN BOARD ASSEMBLY, MODEL V34A—		1	NLS		
	11520-100	—MAIN BOARD ASSEMBLY, MODEL V35A—		1	NLS		
	15004-126	Cable, Input		1	NLS		
	15004-125	Cable, External Reference		1	NLS		
K1	KRP11D	Relay, DPDT, 12 VDC, 120 Ohm Coil		1	Potter-Brumfield		
	11400-750	Adapter, Decade 5	1	1	NLS		X
R51	AW1224-45001M	Resistor, 45K Ohms, ¼W, .05%, Long Leads		1	NLS		X
R52	AW1224-55550M	Resistor, 5.555K Ohms, ¼W, .05%, Long Leads		1	NLS		X
	12110-004	Spring, Bulb Base Contact	10	60	NLS		
S4	11420-120	Switch, Power, with Mtg. Hardware		1	NLS		
S3	11420-121	Switch, Mode, with Mtg. Hardware		1	NLS		
S1	11420-122	Switch, Function, with Mtg. Hardware		1	NLS		
S2	11420-123	Switch, Range, with Mtg. Hardware		1	NLS		
R3	11420-111	Potentiometer, with Mtg. Hardware		1	NLS		
CR5, CR6	1N1124R	Diode	4	2	TI		

Section VI

PARTS LIST

Circuit Reference	Part Number	Description	Spares Req'd Per Year For Ten Units	Qty Per Unit	Manufacturer	Not Used In	
						V34A	V35A
CR7, CR8	1N2071	Diode	4	2	TI		
CR12-CR19	5003-002	Diode	10	8	NLS		
CR9	¾M8.2Z5	Diode	1	1	Motorola		
C2	5002-002	Capacitor		1	NLS		
C1	52RM25	Capacitor, Electrolytic,25 Mfd, 25 VDCW	2	1	Ind. Cond.		
C4, C5	1B1011RTK	Capacitor, Electrolytic, 3 × 250 Mfd, 50 VDCW	2	1	Ind. Cond.		
C3, C6	1B1246A	Capacitor, Electrolytic, 4000 Mfd, 25 VDCW		2	Ind. Cond.		
L1	11400-108	Choke		1	NLS		
T1	11400-109	Transformer		1	NLS		
R8-R10		Resistor, .6 Ohm, 5W, 1%	4	3	PRC		
R11	GB39G1	Resistor, 3.9 Ohm, 1W, 10%		1	AB		
R12	GB1315	Resistor, 130 Ohm, 1W, 5%		1	AB		
R2	EB2711	Resistor, 270 Ohm, ½W, 10%		1	AB		
R15	EB1021	Resistor, 1 K Ohm, ½W, 10%		1	AB		
R1	EB4721	Resistor, 4.7 K, ½W, 10%		1	AB		
R16	DCM¼	Resistor, 50 K Ohm, ¼W, 1%		1	Electra		
F1	313001	Fuse, 1 Amp, Slo-Blo, 3AG	20	1	Littelfuse		
	11420-050	–ZENER SUPPLY ASSEMBLY–	2	1	NLS		
Q1	2N526	Transistor		1	G. E.		
CR1, 2, 3, 4, 6	1N2071	Diode		5	TI		
CR5	1N429	Diode		1	Hoffman		
K1	5005-003	Relay	10	1	NLS		
C1	05RTK500	Capacitor, Electrolytic, 500 Mfd, 50 VDCW		1	Ind. Cond.		
C2	05RM100	Capacitor, Electrolytic, 100 Mfd, 50 VDCW		1	Ind. Cond.		
R6	W101-P1-17	Potentiometer, 17 Ohm, 10%		1	Atohm		
R10	W101-P1-60	Potentiometer, 60 Ohm, 10%		1	Atohm		
R4	W5-P2-200	Potentiometer, 200 Ohm, 10%		1	Atohm		
R2	GB56G1	Resistor, 5.6 Ohm, 1W, 10%		1	AB		
R1		Resistor, .6 Ohm, 5W, 1%		1	PRC		
R11	PW1719-00500S	Resistor, 50 Ohm, ½W, 1%		1	NLS		
R12	PW1719-01000R	Resistor, 100 Ohm, ½W, .5%		1	NLS		
R13	PW1719-02000P	Resistor, 200 Ohm, ½W, .25%		1	NLS		
R3	PW1719-03000P	Resistor, 300 Ohm, ½W, .25%		1	NLS		
R14	PW1719-04000P	Resistor, 400 Ohm, ½W, .25%		1	NLS		
R15	PW1719-08000N	Resistor, 800 Ohm, ½W, .1%		1	NLS		
R5	PW1719-10000P	Resistor, 1 K Ohm, ½W, .25%		1	NLS		
R16	PW1719-16000N	Resistor, 1.6 K Ohm, ½W, .1%		1	NLS		
R7, R9	PW1719-32000P	Resistor, 3.2 K Ohm, ½W, .25%		2	NLS		
R17	PW1719-32000M	Resistor, 3.2 K Ohm, ½W, .05%		1	NLS		
R18	PW1719-70000M	Resistor, 7 K Ohm, ½W, .05%		1	NLS		
R8	PW1719-25001S	Resistor, 25 K Ohm, ½W, 1%		1	NLS		
	11420-054	Oven Assembly		1	NLS		

Section VI

PARTS LIST

Circuit Reference	Part Number	Description	Spares Req'd Per Year For Ten Units	Qty Per Unit	Manufacturer	Not Used In	
						V34A	V35A
CR21	5003-001	Diode		1	NLS		
R21	PW1719-01000R	Resistor, 100 Ohm, ½W, .5%, ⅜" Leads		1	NLS		
	11420-200	—"A" BOARD ASSEMBLY—	2	1	NLS		
Q1-Q10	2N1374	Transistor		10	TI		
CR1-CR33	5003-002	Diode		33	NLS		
C6	ME1-105	Capacitor, Metalized Paper, 1 Mfd, 100 VDCW		1	Electron		
C4	DE2-473E	Capacitor, Metalized Mylar, .047 Mfd, 200 VDCW		1	Electron		
C2, 3, 5, 7, 8, 9, 10, 11	BT. 02	Capacitor, .02 Mfd, ±20%, 100 VDCW		8	RMC		
R53	275-1-103	Potentiometer, 10 K Ohm		1	Bourns		
R41, R51	EB 1011	Resistor, 100 Ohm, ½W, 10%		2	AB		
R26	EB 2015	Resistor, 200 Ohm, ½W, 5%		1	AB		
R1, 8, 10, 17, 19, 30, 38, 39, 43, 50	EB 1021	Resistor, 1 K Ohm, ½W, 10%		10	AB		
R20, 24, 44, 48	EB 2221	Resistor, 2.2 K Ohm, ½W, 10%		4	AB		
R3	EB 2721	Resistor, 2.7 K Ohm, ½W, 10%		1	AB		
R9, 23, 27, 29, 37	EB 4721	Resistor, 4.7 K Ohm, ½W, 10%		5	AB		
R2, 4, 12, 15, 21, 22, 28, 31, 33, 35, 40, 45, 46, 47	EB 1031	Resistor, 10 K Ohm, ½W, 10%		14	AB		
R6	EB 1335	Resistor, 13 K Ohm, ½W, 5%		1	AB		
R7	EB 1831	Resistor, 18 K Ohm, ½W, 10%		1	AB		
R5, 11, 13, 14, 16, 18, 25, 32, 34, 35, 42, 49	EB 2731	Resistor, 27 K Ohm, ½W, 10%		12	AB		
	11420-300	—"B" BOARD ASSEMBLY—	2	1	NLS		
Q1-7, 9, 10	2N1374	Transistor		9	TI		
Q8	2N444A	Transistor		1	GT		
CR1-11, 13-41	5003-002	Diode		40	NLS		
CR12	¼M6.8Z	Diode		1	Motorola		
C9	DE2-473E	Capacitor, Metalized Mylar, .047 Mfd, 200 VDCW		1	Electron		
C1-8, 10, 11	BT. 02	Capacitor, .02 Mfd, ±20%, 100 VDCW		10	RMC		
R1, 10	EB 6215	Resistor, 620 Ohm, ½W, 5%		2	AB		
R12, 21, 23, 31, 39, 40, 41, 44, 45, 46, 47, 56	EB 1021	Resistor, 1 K Ohm, ½W, 10%		12	AB		
R16	EB 1521	Resistor, 1.5 K Ohm, ½W, 10%		1	AB		
R14, 17, 38	EB 2221	Resistor, 2.2 K Ohm, ½W, 10%		3	AB		

Section VI

PARTS LIST

Circuit Reference	Part Number	Description	Spares Req'd Per Year For Ten Units	Qty Per Unit	Manufacturer	Not Used In	
						V34A	V35A
R5, 6, 18, 26, 29, 34, 36, 43, 51, 52	EB 4721	Resistor, 4.7 K Ohm, ½W, 10%		10	AB		
R3, 8, 13, 25, 30, 33, 37, 42, 49, 54	EB 1031	Resistor, 10 K Ohm, ½W, 10%		10	AB		
R2, 4, 7, 9, 11, 15, 19, 20, 22, 27, 28, 35, 50, 53, 55	EB 2731	Resistor, 27 K Ohm, ½W, 10%		15	AB		
R24, 32, 48	EB 2241	Resistor, 220 K Ohm, ½W, 10%		3	AB		
	11420-400	—"C" BOARD ASSEMBLY—	2	1	NLS		
Q1-11	2N1374	Transistor		11	TI		
CR1-32	5003-002	Diode		32	NLS		
C2	52RM25	Capacitor, Electrolytic, 25 Mfd, 25 VDCW		1	Ind. Cond.		
C6, 7	DE2-473E	Capacitor, Metalized Mylar, .047 Mfd, 200 VDCW		2	Electron		
C1, 3, 4, 5, 8, 9, 10, 11	BT .02	Capacitor, .02 Mfd, ±20%, 100 VDCW		8	RMC		
R1, 11, 15, 22, 23, 24, 32, 35, 36	EB 1021	Resistor, 1 K, ½W, 10%		9	AB		
R17, 26, 38	EB 1521	Resistor, 1.5 K Ohm, ½W, 10%		3	AB		
R4, 10, 12, 13, 20, 30, 41	EB 2221	Resistor, 2.2K Ohm, ½W, 10%		7	AB		
R2, 6, 8, 14, 19, 29, 33, 40	EB 4721	Resistor, 4.7 K Ohm, ½W, 10%		8	AB		
R3, 7, 9, 18, 28, 34, 39	EB 1031	Resistor, 10 K Ohm, ½W, 10%		7	AB		
R5, 25, 27, 31, 37, 42	EB 2731	Resistor, 27 K Ohm, ½W, 10%		6	AB		
R16, 21	EB 2241	Resistor, 220 K Ohm, ½W, 10%		2	AB		
	11420-500	—"D" BOARD ASSEMBLY—	2	2	NLS		
Q2, 4, 6	2N1540	Transistor		3	Motorola		
Q1, 3, 5	2N1374	Transistor		3	TI		
CR1, 2, 3	5003-002	Diode		3	NLS		
C1, 2, 3	ME1-105	Capacitor, Metalized Paper, 1 Mfd, 100 VDCW		3	Electron		
R1, 5, 9	GB 1011	Resistor, 100 Ohm, 1W, 10%		3	AB		
R4, 8, 12	EB 1021	Resistor, 1 K Ohm, ½W, 10%		3	AB		
R2, 3, 6, 7, 10, 11	EB 4721	Resistor, 4.7 K Ohm, ½W, 10%		6	AB		
	11420-600	—AMPLIFIER ASSEMBLY—	2	1	NLS		
T1	11420-607	Transformer, Isolation		1	NLS		
T2	11420-608	Transformer, Input		1	NLS		
T3	11420-609	Transformer, Interstage		1	NLS		

Section VI

PARTS LIST

Circuit Reference	Part Number	Description	Spares Per Year For Ten Units Req'd	Qty Per Unit	Manufacturer	Not Used In	
						V34A	V35A
T4	11420-610	Transformer, Output		1	NLS		
Q1, 2, 3	2N1301	Transistor		3	RCA		
Q6, 7, 8, 9	2N582	Transistor		4	RCA		
Q10	2N1374	Transistor		1	TI		
Q4, 5	2N444A	Transistor		2	GT		
CR11, 12	1N662	Diode		2	Transitron		
CR2-5, 7, 8, 10, 13, 14, 15	5003-002	Diode		10	NLS		
CR6	1N749A	Diode		1	TI		
CR9	¼M6.8Z10	Diode		1	Motorola		
C5, 7	TE 1135	Capacitor, Electrolytic, 100 Mfd, 12 VDCW		2	Sprague		
C4	5002-001	Capacitor		1	NLS		
C6	ME1-105	Capacitor, Metalized Paper, 1 Mfd, 100 VDCW		1	Electron		
C8	ME1-254E	Capacitor, Metalized Paper, .25 Mfd, 10%, 100 VDCW		1	Electron		
C3	DD391	Capacitor, Ceramic, 390 Mmfd, 10%, 1000 VDCW		1	Centralab		
R16	275-1-501	Potentiometer, 500 Ohm		1	Bourns		
R28	275-1-102	Potentiometer, 1 K Ohm		1	Bourns		
R18	275-1-202	Potentiometer, 2 K Ohm		1	Bourns		
R31	EB 1615	Resistor, 160 Ohm, ½W, 5%		1	AB		
R24, 32	EB 3015	Resistor, 300 Ohm, ½W, 5%		2	AB		
R21	EB 3615	Resistor, 360 Ohm, ½W, 5%		1	AB		
R29	EB 5615	Resistor, 560 Ohm, ½W, 5%		1	AB		
R26, 42, 45	EB 1021	Resistor, 1 K Ohm, ½W, 10%		3	AB		
R23, 27	EB 1125	Resistor, 1.1 K Ohm, ½W, 5%		2	AB		
R22, 34, 37	EB 2025	Resistor, 2 K Ohm, ½W, 5%		3	AB		
R19, 25	EB 2425	Resistor, 2.4 K Ohm, ½W, 5%		2	AB		
R15	EB 3625	Resistor, 3.6 K Ohm, ½W, 5%		1	AB		
R35, 38, 46, 47, 48, 50	EB 4721	Resistor, 4.7 K Ohm, ½W, 10%		6	AB		
R53	EB 5125	Resistor, 5.1 K Ohm, ½W, 5%		1	AB		
R17	EB 7525	Resistor, 7.5 K Ohm, ½W, 5%		1	AB		
R33	EB 9125	Resistor, 9.1 K Ohm, ½W, 5%		1	AB		
R40, 41, 43, 44, 49, 51	EB 1031	Resistor, 10 K Ohm, ½W, 10%		6	AB		
R36, 39	EB 1531	Resistor, 15 K Ohm, ½W, 10%		2	AB		
R52, 54	EB 2731	Resistor, 27 K Ohm, ½W, 10%		2	AB		
R14	EB 1135	Resistor, 11 K Ohm, ½W, 5%		1	AB		
R20	EB 1305	Resistor, 13 Ohm, ½W, 10%		1	AB		
R30	EB 3005	Resistor, 30 Ohm, ½W, 5%		1	AB		
K3	C 1417-15	Chopper	2	1	Bristol		
CR1	5003-003	Diode		1	NLS		

Section VI

PARTS LIST

Circuit Reference	Part Number	Description	Spares Req'd Per Year For Ten Units	Qty Per Unit	Manufacturer	Not Used In	
						V34A	V35A
C1	XK2-682	Capacitor, Polystyrene, .0068 Mfd, 200 VDCW		1	Electron		
C2	XL2-222	Capacitor, Polystyrene, .0022 Mfd, 200 VDCW		1	Electron		
R12	025-OL-1-20	Potentiometer, 20 Ohm		1	Conelco		
R10	025-OL-1-200	Potentiometer, 200 Ohm		1	Conelco		
R8	025-OL-1-2K	Potentiometer, 2 K Ohm		1	Conelco		
R2-7	PW1719B-15003M	Resistor, 1.5 Meg, ½W, .05%, Aqua		6	NLS		
R9	PW1719B-89902M	Resistor, 899 K Ohm, ½W, .05%, Orange		1	NLS		
R11	PW1719B-89901M	Resistor, 89.9 K Ohm, ½W, .05%, Red		1	NLS		
R13	PW1719B-99910M	Resistor, 9.9911 K Ohm, ½W, .05%, Brown		1	NLS		
R1	GB 1051	Resistor, 1 Meg, 1W, 10%		1	AB		
K1, 2	5005-003	Relay		2	NLS		
	11420-800	—RELAY BOARD ASSEMBLY, RANGE & POLARITY—	2	1	NLS		
K1-4	5005-002	Relay		4	NLS		
Q1	2N1374	Transistor		1	TI		
CR1	5003-002	Diode	10	2	NLS		
R3	EB 1021	Resistor, 1 K Ohm, ½W, 10%		1	AB		
R2	EB 2221	Resistor, 2.2 K Ohm, ½W, 10%		1	AB		
R1	EB 1031	Resistor, 10 K Ohm, ½W, 10%		1	AB		
	11420-830	—RELAY BOARD ASSEMBLY, FUNCTION AC-DC—	2	1	NLS		
K1, 2	5005-002	Relay		2	NLS		
CR2-5	1N2071	Diode		4	TI		
CR1	5003-002	Diode		1	NLS		
C1	ME1-105	Capacitor, Metalized Paper, 1 Mfd, 100 VDCW		1	Electron		
C2	DE2-473E	Capacitor, Metalized Mylar, .047 Mfd, 200 VDCW		1	Electron		
R1	GB 5125	Resistor, 5.1 K Ohm, 1W, 5%		1	AB		
R2, 3	EB 2731	Resistor, 27 K Ohm, ½W, 10%		2	AB		
	12183	—READOUT ASSEMBLY, 3W5, INVERTED, SWING-OUT TYPE—		1	NLS		X
	12184	—READOUT ASSEMBLY, 3W5, INVERTED, SWING-OUT TYPE—		1	NLS	X	
	12145-001-3	Spring, Side Contact		7	NLS		X
	330	Bulb, 14 V	100	46	G.E.		X
	12145-001-3	Spring, Side Contact		8	NLS	X	
	330	Bulb, 14 V	100	56	G.E.	X	

Section VI

PARTS LIST

Circuit Reference	Part Number	Description	Spares Req'd Per Year For Ten Units	Qty Per Unit	Manufacturer	Not Used In V34A	Not Used In V35A
	11420-860	—DECIMAL CHECK ASSEMBLY—	1	1	NLS		
Q1, 2	2N1374	Transistor		2	TI		
R1, 2, 5	EB 1031	Resistor, 10 K, ½W, ±10%		3	AB		
R3, 4	EB 4721	Resistor, 4.7K, ½W, ±10%		2	AB		
CR3, 4, 5	5003-002	Diode		3	NLS		
	11420-700	—DECADE SWITCH ASSEMBLY—	2	4	NLS		X
	11520-700	—DECADE SWITCH ASSEMBLY—	2	5	NLS	X	
	11420-730	—TRANSFER SWITCH ASSEMBLY—	2	1	NLS		

LIST OF MANUFACTURERS

Allen Bradley Company
Milwaukee, Wisconsin

Amphenol Electronics, Inc.
Chicago 50, Illinois

Armel Electronics, Inc.
Los Angeles, California

Atohm Electronics
Sun Valley, California

Birnbach
New York, New York

Borden Chemical Company
Compton, California

Bourns
Riverside, California

Bristol
Waterbury 20, Connecticut

Centralab Division, Globe Union, Inc.
Milwaukee, Wisconsin

Cinch Manufacturing
Chicago, Illinois

Conelco
Monrovia, California

Consolidated Electrodynamics Corporation
Pasadena, California

Edwin B. Stimpson
Brooklyn, New York

Elco Corporation
Philadelphia 24, Pennsylvania

Electra
Kansas City, Missouri

Electron Products, Inc.
Pasadena, California

General Cement
Rockford, Illinois

General Electric Company, Miniature Lamp Dept.
Cleveland, Ohio

General Transistor Corporation
Los Angeles, California

Heyco
Los Angeles, California

Herman H. Smith
Brooklyn, New York

Hoffman Electronics Corporation, Semi-Conductor Division
Evanston, Illinois

Ilumtronic Engineering
Sunnyvale, California

Industrial Condenser
Chicago, Illinois

Industrial Devices
Los Angeles, California

Jadaro
Garland, Texas

Lerco
Burbank, California

Littelfuse
Des Plaines, Illinois

Motorola Semiconductor Products, Inc.
Phoenix, Arizona

Non-Linear Systems, Inc.
Del Mar, California

Nylon Mould Corporation
Garwood, New Jersey

Potter Brumfield
Princeton, Illinois

Precision Resistor Corporation
Hillside, New Jersey

Radio Corporation of America,
Electron Tube Division
Harrison, New Jersey

Semi-Conductor Division
Summerville, New Jersey

Raytheon Manufacturing Company,
Commercial Equipment Division
Waltham, Massachusetts

R. G. Wallace
Los Angeles, California

Saxon Or Equivalent
Burbank, California

Sealectro Corporation
Mamaronek, New York

Sprague Electric Company
Los Angeles, California

Spruce Pine Mica Company
Spruce Pine, North Carolina

Standard Pressed Steel Company
Santa Ana, California

Texas Instruments
Dallas, Texas

Transitron Electronic Corporation
Hollywood, California

United States Plywood Corporation,
Engineered Products Dept.
New York, New York

Walsco Electronics Manufacturing Company
Los Angeles, California

Winchester Electronics, Inc.
San Diego, California

Zierick Manufacturing Corporation
New Rochelle, New York

Section VII

APPENDIX

WARRANTY

Non-Linear Systems, Inc., warrants each instrument of its manufacture to be free from defects in material and workmanship. Our obligation under this Warranty is limited to servicing any instrument returned prepaid to our factory for that purpose within one year of delivery to the original purchaser. Serviced instruments are returned F.O.B. Del Mar, Calif. Tubes, semiconductors, choppers, and lamp bulbs are exempted from this Warranty. Non oil-bath stepping switches are warranted for ninety days.

Instruments returned to the factory are accepted only when prior authorization has been given by an authorized representative of Non-Linear Systems, Inc.

Non-Linear Systems, Inc., reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

No warranty issuing from any source other than Non-Linear Systems, Inc., is valid.

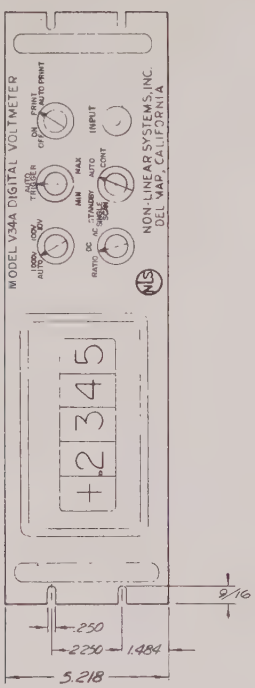
SHIPPING INSTRUCTIONS

Depending upon location, the choice of carrier will vary. Never ship an instrument to us without having received shipping instructions. If requested, an estimate of charges can be made before work begins.

Be certain to pack the instrument carefully; while an outer and inner box, separated by two or three inches of excelsior is desirable, the instrument can be placed into a single container provided it is so packed that it will not shift about. As with the double box method, use two or three inches of shock-absorbent packing materials. The instrument itself should be first wrapped in heavy paper so as to keep excelsior or other particles from entering the instrument's louvres.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it does not operate or is damaged, a claim should be made with the carrier. The claim agent should receive a full report of damage, and this report sent to Non-Linear Systems, Inc. After receiving such a report, we will advise you of the disposition of the instrument and arrange for its repair or replacement. Be certain to include model and serial number when corresponding.



INSTRUMENT CHARACTERISTICS

GENERAL

STRUCTURE FABRICATED FROM ALUMINUM ALLOY
PRINTED CIRCUIT BOARDS MADE FROM COPPER CLAD EPOXY
READOUT WINDOWS MADE FROM PLEXIGLASS
VISOR MADE FROM HIGH IMPACT STYRENE PLASTIC
FRONT PANEL PAINTED LIGHT GRAY PER MIL-E-15090B, TYPE 3, CLASS 1
CABINET FINISHED IN GOLD IRIDITE

ELECTRICAL

DIGITS DISPLAYED - 4
VOLTAGE RANGE, DC VOLTS: ±.9999/ 9.999/99.99/ 999.9
RANGE CHANGING: AUTOMATIC
POLARITY CHANGING: AUTOMATIC
INPUT IMPEDANCE: 10 MEGOHMS
INTERNAL REFERENCE VOLTAGE: TEMPERATURE COMPENSATED, ZENER DIODE TYPE DC POWER SUPPLY

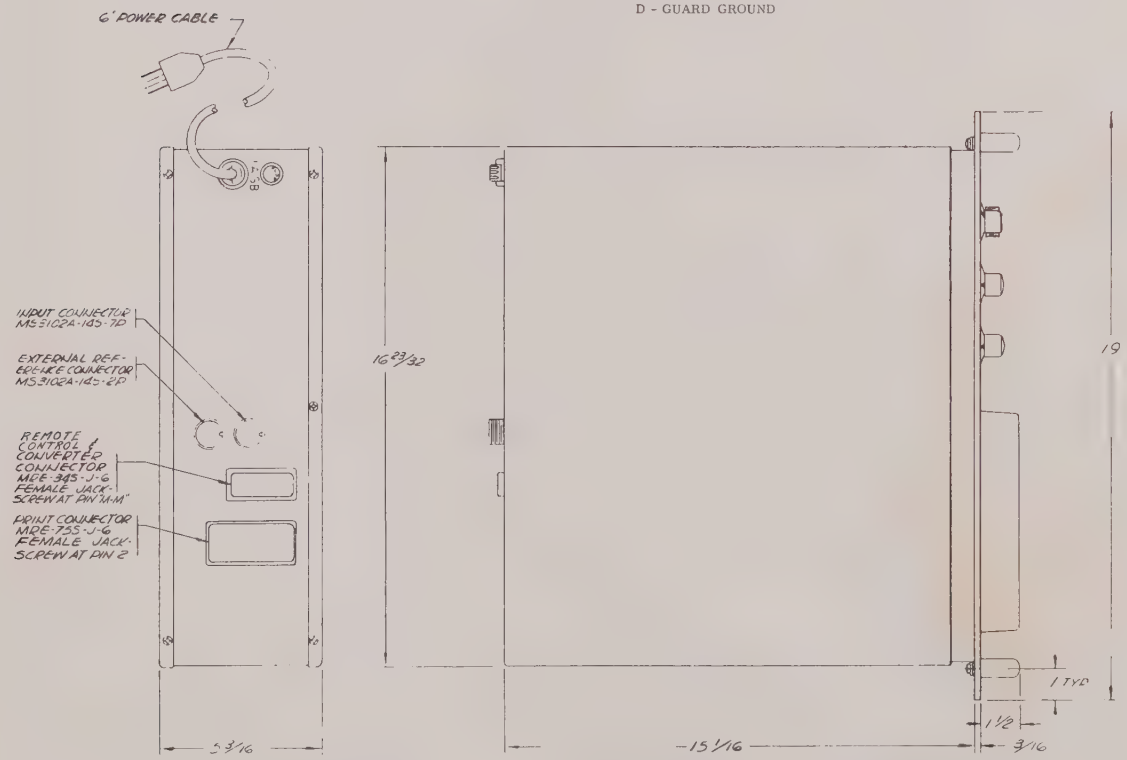
ACCURACY: ± 1 DIGIT
REMOTE CONTROL ON ALL FUNCTIONS EXCEPT RATIO
RESOLUTION: 1 DIGIT
EXTERNAL REFERENCE VOLTAGE ±10 VDC
EXTERNAL REFERENCE LOAD 50,000 OHMS
PRIMARY POWER: 115/230 VOLTS ±10%, 50-60 CPS
APPROXIMATELY 50 VOLT-AMPS

FEATURES

INDIVIDUAL PLUG-IN OIL BATH STEPPING SWITCHES
COMPLETELY TRANSISTORIZED
BALANCING TIME MAXIMUM: 1.9 SECONDS
AVERAGE: .75 SECOND
SNAP IN READOUT

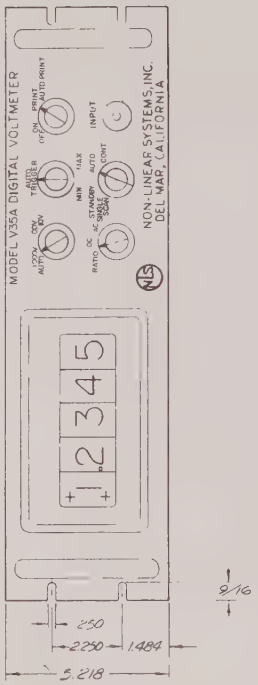
CONNECTIONS

SIGNAL INPUT CONNECTOR:
A - SIGNAL HIGH
B - SIGNAL LOW
C - GUARD GROUND
EXTERNAL REFERENCE CONNECTOR:
A - +REFERENCE
B - -REFERENCE
C - REFERENCE COMMON
D - GUARD GROUND



NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED — DIMENSIONS ARE IN INCHES — TOLERANCES ON FRACTION ±1/32, DECIMAL .X ±.03, ANGLES ±°
MATERIAL —
DRAWN BY A R WALLIN — DATE 1-26-61
CHECKED BY R. Hochstetler — DATE 2-20-61
FINISH —
TITLE: DIGITAL VOLTMETER MODEL V34A OUTLINE DRAWING
SCALE 1/8 — WT —
NON-LINEAR SYSTEMS INC. DEL MAR AIRPORT DEL MAR, CALIFORNIA
DRAWING NUMBER 11420
SHEET 3



INSTRUMENT CHARACTERISTICS

GENERAL

STRUCTURE FABRICATED FROM ALUMINUM ALLOY
PRINTED CIRCUIT BOARDS MADE FROM COPPER CLAD EPOXY
READOUT WINDOWS MADE FROM PLEXIGLASS
VISOR MADE FROM HIGH IMPACT STYRENE PLASTIC
FRONT PANEL PAINTED LIGHT GRAY PER MIL-E-15090B, TYPE 3, CLASS 1
CABINET FINISHED IN GOLD IRIDITE

ELECTRICAL

DIGITS DISPLAYED - 5
VOLTAGE RANGE, DC VOLTS: ±9.9999/99.999/999.99
RANGE CHANGING: AUTOMATIC
POLARITY CHANGING: AUTOMATIC
INPUT IMPEDANCE: 10 MEGOHMS
INTERNAL REFERENCE VOLTAGE: TEMPERATURE COMPENSATED, ZENER DIODE TYPE DC POWER SUPPLY

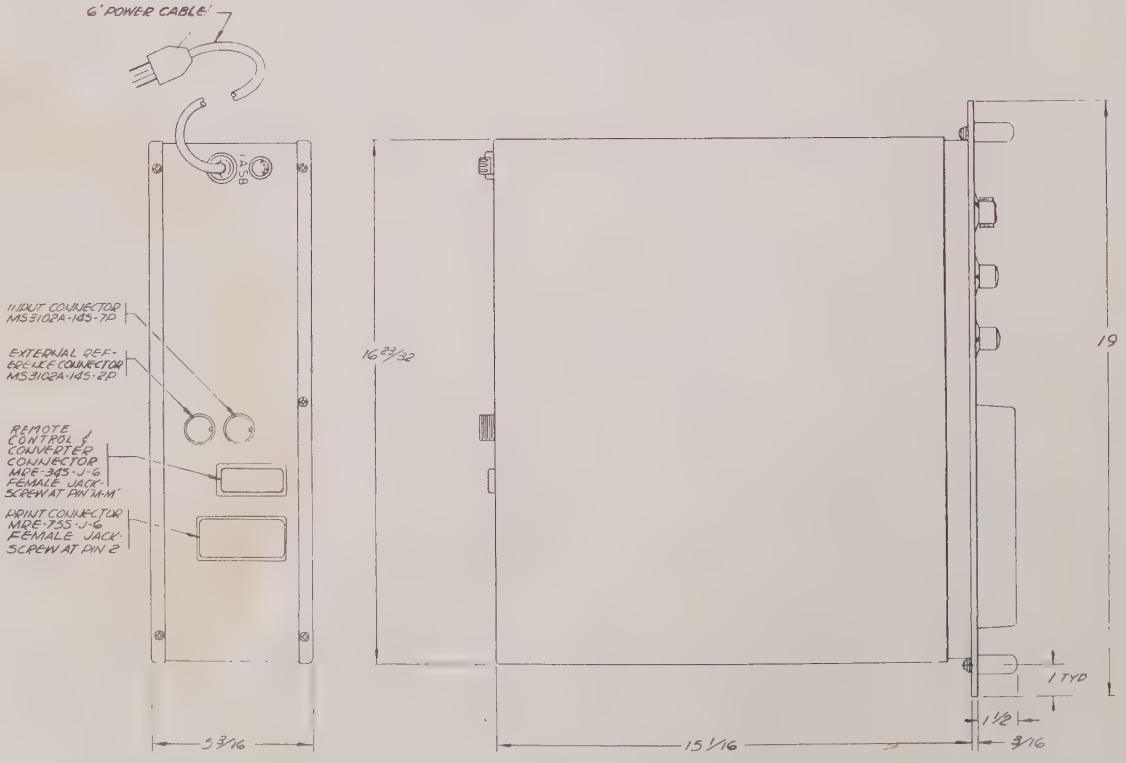
ACCURACY: ± .01% OF READING OR ± 1 DIGIT
REMOTE CONTROL ON ALL FUNCTIONS EXCEPT RATIO
RESOLUTION: 1 DIGIT
EXTERNAL REFERENCE VOLTAGE ±100 VDC
EXTERNAL REFERENCE LOAD 50,000 OHMS
PRIMARY POWER: 115/230 VOLTS ±10%, 50-60 CPS
APPROXIMATELY 50 VOLT-AMPS

FEATURES

INDIVIDUAL PLUG-IN OIL BATH STEPPING SWITCHES
COMPLETELY TRANSISTORIZED
BALANCING TIME MAXIMUM: 2.3 SECONDS
AVERAGE: 1 SECOND
SNAP IN READOUT

CONNECTIONS

SIGNAL INPUT CONNECTOR:
A - SIGNAL HIGH
B - SIGNAL LOW
C - GUARD GROUND
EXTERNAL REFERENCE CONNECTOR:
A - +REFERENCE
B - -REFERENCE
C - REFERENCE COMMON
D - GUARD GROUND

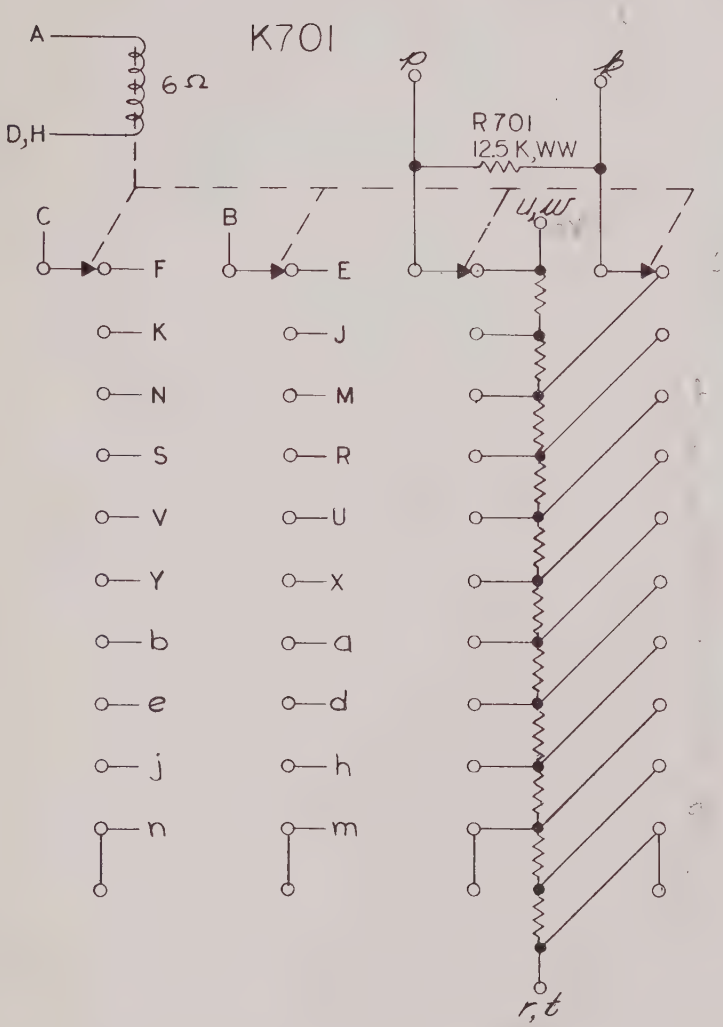


UNLESS OTHERWISE SPECIFIED	DRAWN BY A. E. WALLIN	DATE 1-26-61	TITLE DIGITAL VOLTMETER MODEL V35A OUTLINE DRAWING
DIMENSIONS ARE IN INCHES	CHECKED BY	DATE	
FRACTIONS ± 1/32 DECIMAL ± .00 ANGLES ±	ENGINEER BY A. Hochstadt	DATE 2-20-61	
MATERIAL	FINISH		SCALE 1/8 WT

NON-LINEAR SYSTEMS
DEL MAR AIRPORT
DEL MAR, CALIFORNIA

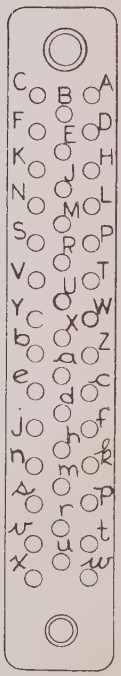
DRAWING NUMBER 11520

SHEET 3



R702 -712
5K,WW

P701



NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

DRAWN BY H. BRINKLEY	DATE 6-10-59
CHECKED BY NAIVE	DATE 6-11-59
APPROVED BY H Clement	DATE 6-12-59
FINISH	

TITLE

DECADE SWITCH ASSEMBLY, SCHEMATIC

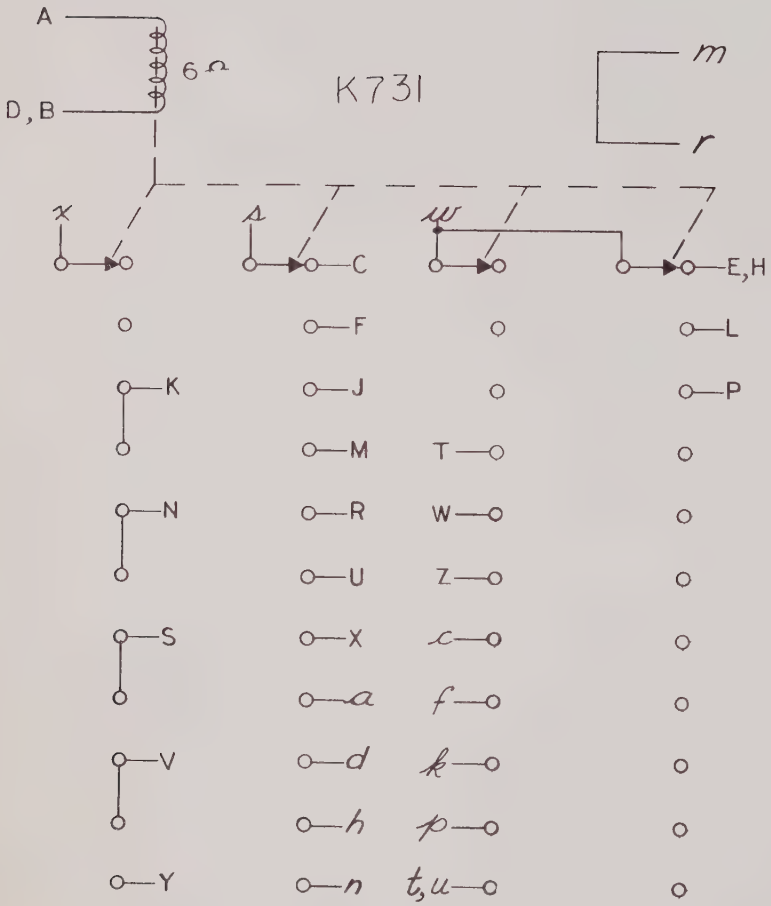
MODEL V34 & V35

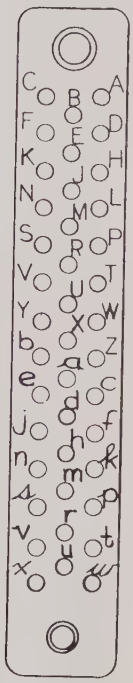
NON-LINEAR SYSTEMS INC.
DEL MAR AIRPORT
DEL MAR, CALIFORNIA

DRAWING NUMBER 11400-700

SCALE | WT. | SHEET 2 OF

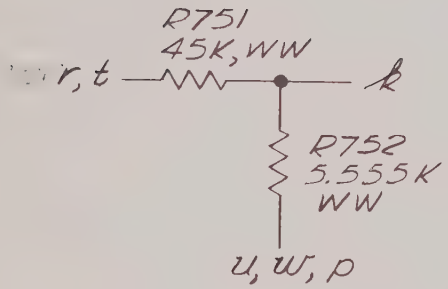
REVISIONS				
SYM.	EFFECT.	DESCRIPTION	DATE	APPROVAL
1	N493, N535, CON	REMOVED ALL JUMPERS	5-17-60 MTS	H Climpt

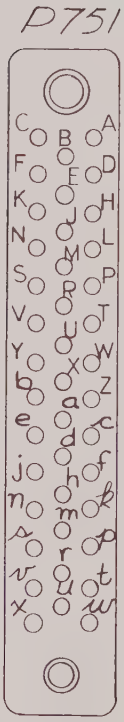




NEXT ASSY	USED ON	NEXT ASSY	FINAL AS
APPLICATION		QTY REQD	

DRAWN BY H. BRINLEY	DATE 6-10-59	TITLE TRANSFER SWITCH ASSEMBLY, SCHEMATIC	NON-LINEAR SYSTEMS INC
CHECKED BY NAIVE	DATE 6-11-59		DEL MAR AIRPORT DEL MAR, CALIFORNIA
APPROVED BY H Climpt	DATE 6-12-59	MODEL V34 & V35	DRAWING NUMBER 11400-730
FINISH		SCALE	WT. SHEET 2 OF



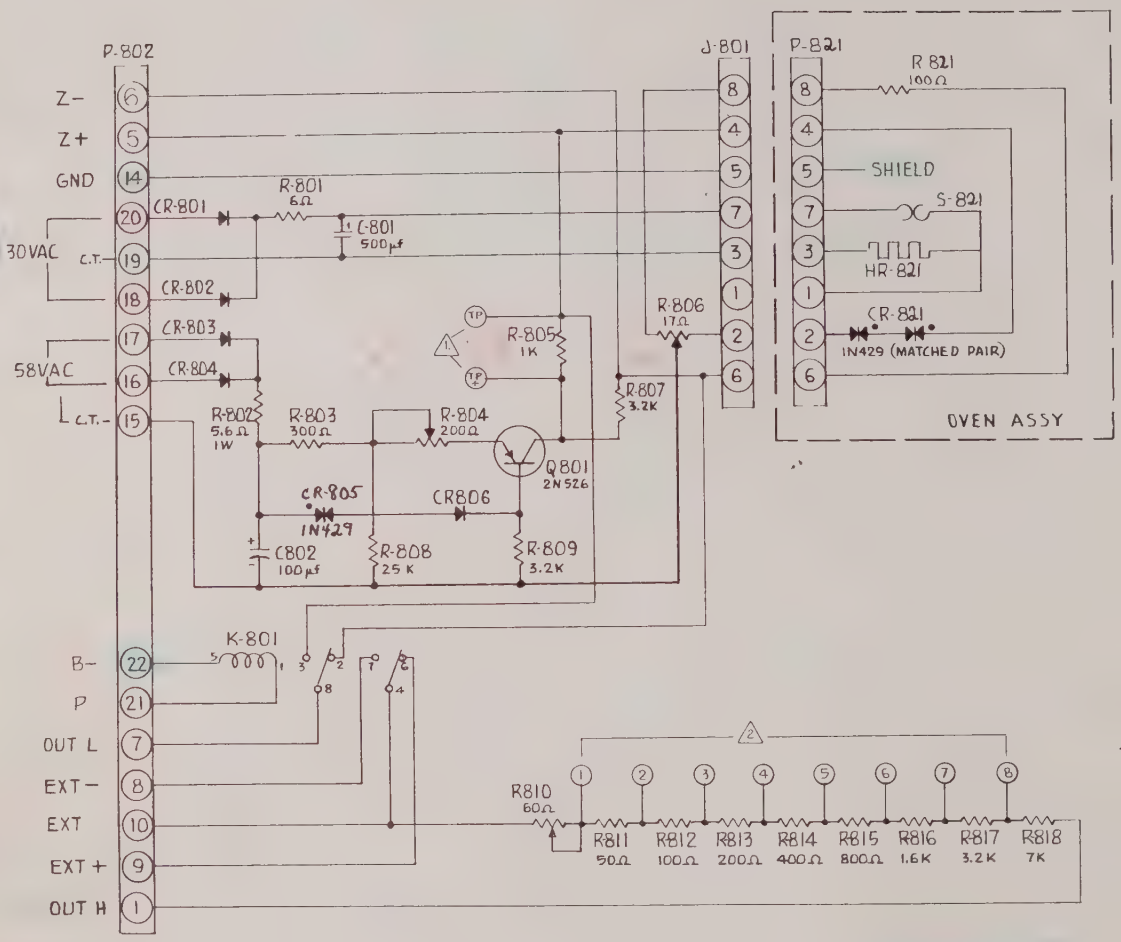


NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTION ± DECIMAL ± ANGLES ±	DRAWN BY H BRINLEY — DATE 7-9-59 CHECKED BY NAIVE — DATE 7-13-59 APPROVED BY SCULE — DATE 7-13-59	TITLE DECADE 5 ADAPTER SCHEMATIC MODEL V 34
MATERIAL FINISH	SCALE WT.	DRAWING NUMBER 11400-750 SHEET 2 OF

NON-LINEAR SYSTEMS INC.
DEL MAR AIRPORT
DEL MAR, CALIFORNIA

REVISIONS				
SYM	EFFECT	DESCRIPTION	DATE	APPROV
1	ALL	CIRCUIT CHG TO ACCOMODATE CHG OF RELAY	27 JAN 60 ADW	7-28-
2	ALL	REVERSED PINS OF "Z-" & "Z+" & PINS 2 & 3 OF "K-801".	19 OCT 60 ADC	10-19-



△2 CERTAIN COMBINATIONS ARE SHORTED TO COMPENSATE FOR ZENER DIODE VOLTAGE (SEE MANUAL)

△1 TP1 & TP2 ARE USED IN ADJUSTING THE ZENER REFERENCE

NOTES—UNLESS OTHERWISE SPECIFIED.

NEXT ASSY	USED ON	NEXT ASSY	FINA
APPLICATION		QTY REQ	

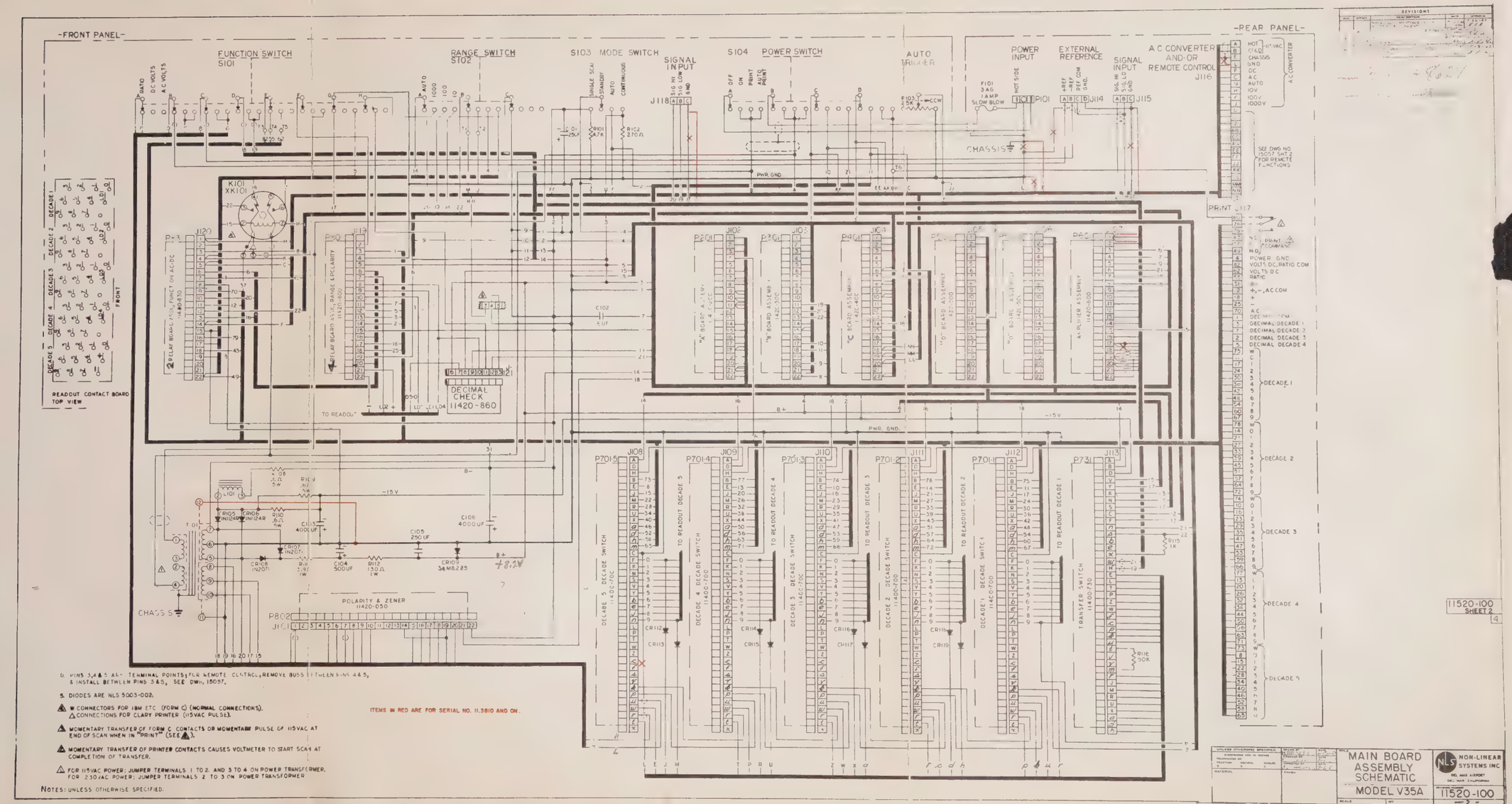
UNLESS OTHERWISE SPECIFIED	DRAWN BY	DATE
DIMENSIONS ARE IN INCHES	A. R. WALLIN	1 JUNE '60
TOLERANCES ON FRACTION ± DECIMAL ± ANGLES ±	CHECKED BY	DATE 6/1/60
MATERIAL	APPROVED BY	DATE
	FINISH	

TITLE
SCHEMATIC—
ZENER SUPPLY ASSEM.
V34A V35A
DIGITAL VOLTMETER

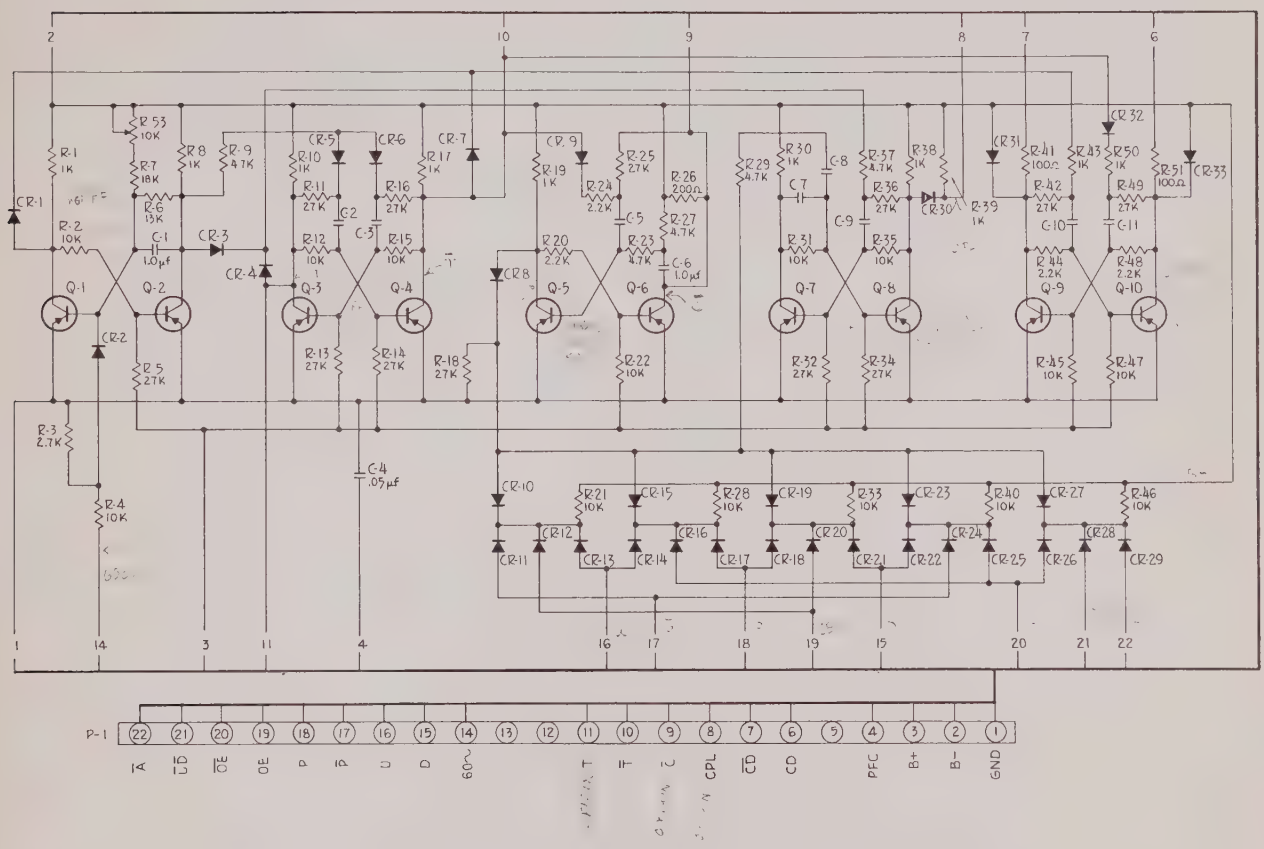
NON-LINE SYSTEMS I
DEL MAR AIRPORT
DEL MAR, CALIFORNIA

DRAWING NUMBER
11420-050

SCALE - | WT | SHEET ' OF


-FRONT PANEL-
FUNCTION SWITCH S101
RANGE SWITCH ST02
S103 MODE SWITCH
SIGNAL INPUT
S104 POWER SWITCH
AUTO TRIGGER
-REAR PANEL-
POWER INPUT
EXTERNAL REFERENCE
SIGNAL INPUT
A C CONVERTER AND-OR REMOTE CONTROL J116
CHASSIS
PWR. GND.
-15 V
B+
+8.2V
DECIMAL CHECK 11420-860
READOUT CONTACT BOARD TOP VIEW
DECADE 1
DECADE 2
DECADE 3
DECADE 4
DECADE 5
FRONT
TO READOUT
POLARITY & ZENER 11420-050
DECADE 5 DECADE SWITCH 11400-700
DECADE 4 DECADE SWITCH 11400-700
DECADE 3 DECADE SWITCH 11400-700
DECADE 2 DECADE SWITCH 11400-700
DECADE 1 DECADE SWITCH 11400-700
TRANSFER SWITCH 11400-750
ITEMS IN RED ARE FOR SERIAL NO. 11.3810 AND ON.
NOTES: UNLESS OTHERWISE SPECIFIED.
MAIN BOARD ASSEMBLY SCHEMATIC MODEL V35A
NON-LINEAR SYSTEMS INC
DEL MAR AIRPORT
DEL MAR, CALIFORNIA
11520-100
SHEET 2

& POLARITY CO.



5. R-6 IS 20 K OHMS IN INSTRUMENT SERIAL NO'S. V35A. 96 (V34A. 96) & ON.
4. ALL COMPONENT REFERENCE NUMBERS ARE IN 200 SERIES, i.e. R 22 = R 222
3. CAPACITORS ARE .02MFD
2. DIODES ARE NLS NO. 5003-002.
1. TRANSISTORS ARE TYPE 2N1374

NOTES - UNLESS OTHERWISE SPECIFIED:

NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON: FRACTION ± DECIMAL ± ANGLES °
MATERIAL

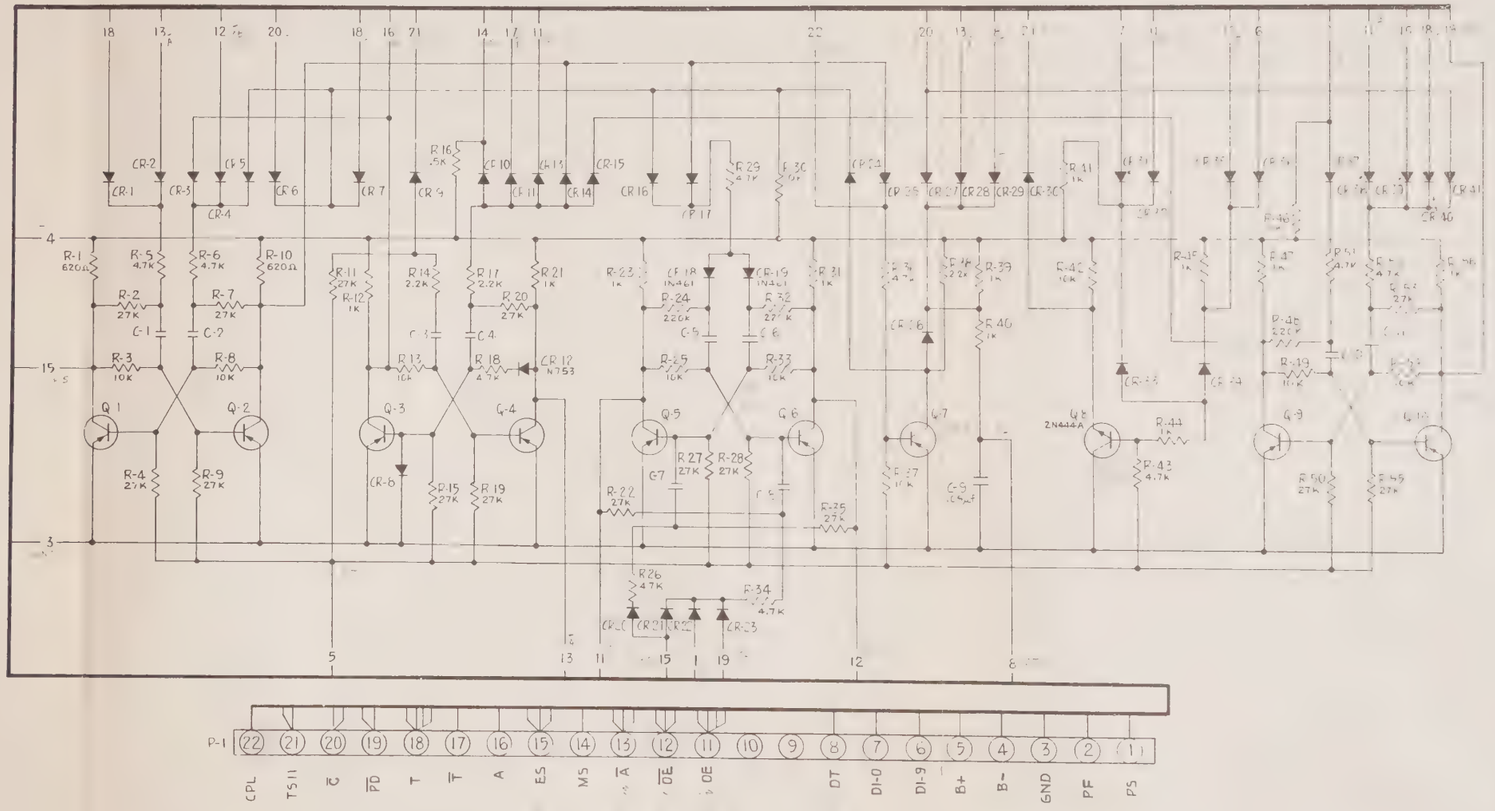
DRAWN BY A. K. WALLIN 8-JUNE-67
CHECKED BY
APPROVED BY
DATE
FINISH

TITLE
SCHEMATIC-
"A" BOARD ASSEMBLY
V34A V35A
DIGITAL VOLTMETER
SCALE WT

NON-LINEAR SYSTEMS INC.
DEL MAR AIRPORT
DEL MAR CALIFORNIA

DRAWING NUMBER
11420-200
SHEET 2 OF

REVISIONS				
SYM	EFFECT	DESCRIPTION	DATE	APP'D
1	ALL	MODIFIED VALUE TO R-43; R-16 WAS 22K		
2	ALL	CHANGED VALUE OF R-16 TO 6.8K.		



4. ALL COMPONENT REFERENCE NUMBERS ARE IN 300 SERIES, i.e. R-26 = R-306
3. CAPACITORS ARE .02 MFD.
2. DIODES ARE NLS NO. 5003-002
1. TRANSISTORS ARE TYPE 2N1374.

NOTES UNLESS OTHERWISE SPECIFIED:

NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

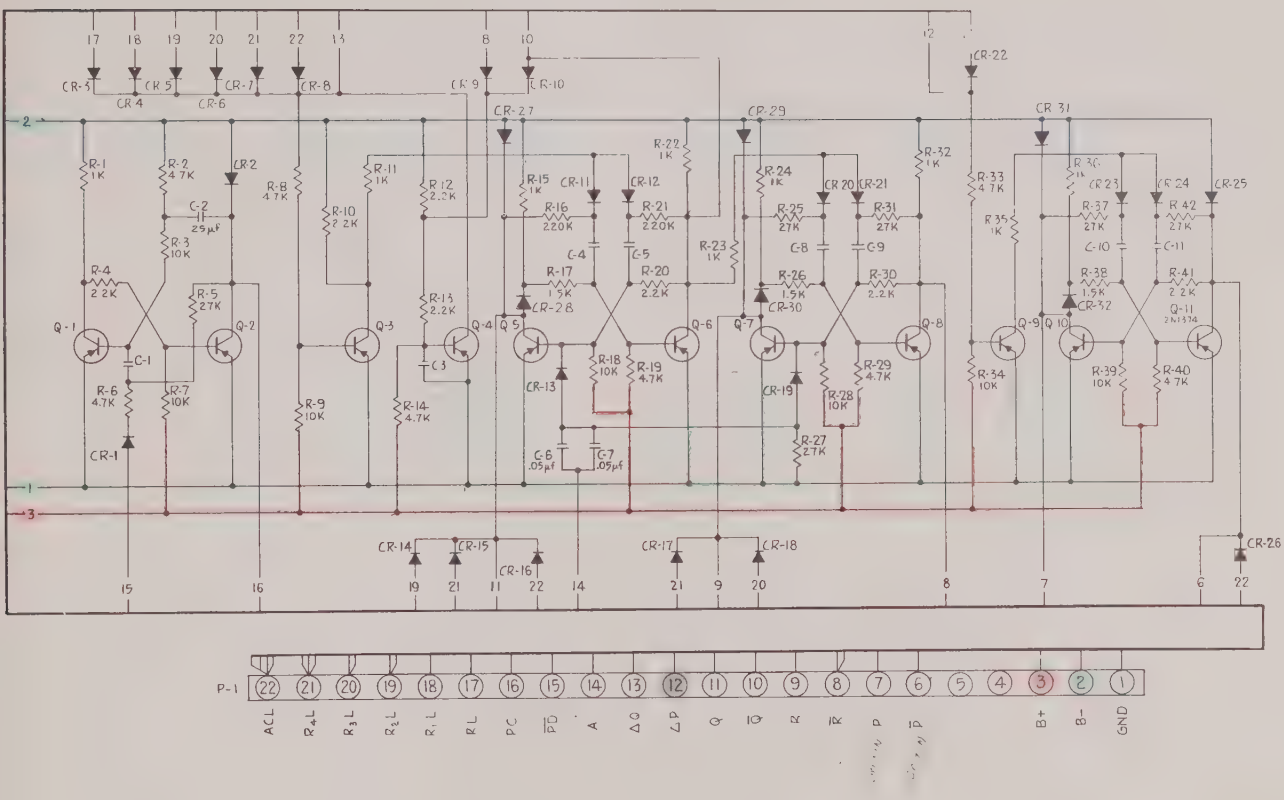
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTION ± DECIMAL ± ANGLE ±
MATERIAL
FINISH
DRAWN
DATE

TITLE
SCHEMATIC —
"B" BOARD ASSEMBLY
V34A V35A
DIGITAL VOLTMETER

NON-LINEAR SYSTEMS INC.
DEL MAR AIRPORT
DEL MAR CALIFORNIA

DRAWING NUMBER
11420-300

SCALE
WT.
SHEET 1 OF



4. ALL COMPONENT REFERENCE NUMBERS ARE IN 400 SERIES, i.e. R-27 = R-427
3. CAPACITORS ARE .02 MFD.
2. DIODES ARE NLS NO. 5003-002
1. TRANSISTORS ARE TYPE 2N1374

NOTES - UNLESS OTHERWISE SPECIFIED:-

NEXT ASSY	USED ON	NEXT HIGH ASSY
APPLICATION		QTY REQD

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTION DECIMAL ANGLES
MATERIAL

DRAWN BY A.E. KELLY
APPROVED
F.N.S.II

DATE 1-24-68

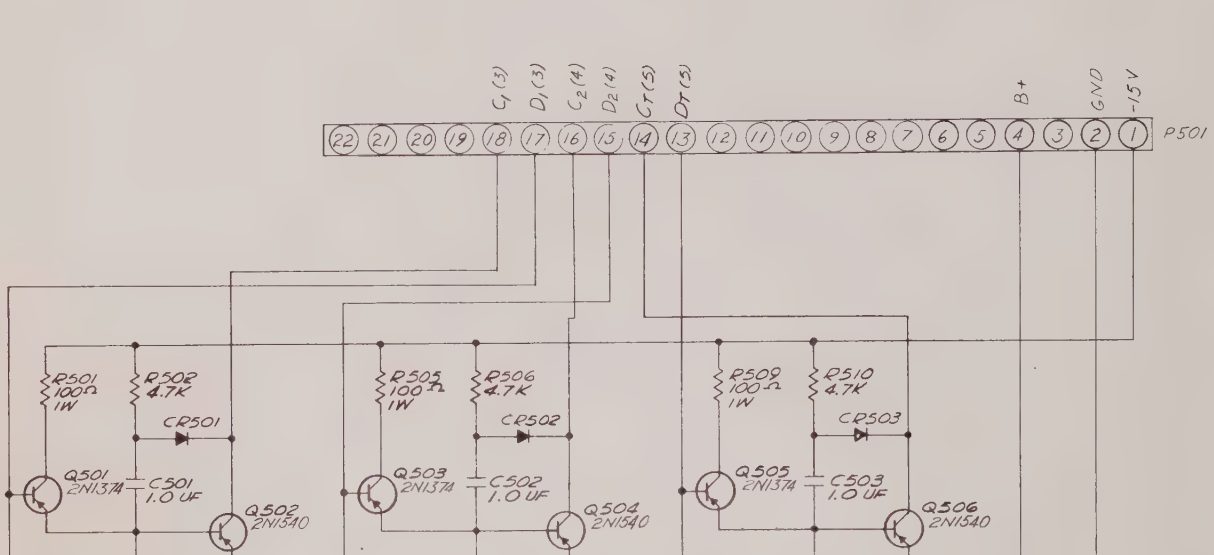
TITLE
SCHEMATIC -
"C" BOARD ASSEMBLY
FOR A 1100
DIGITAL VOLTMETER

SCALE WT

NLS NON-LINEAR SYSTEMS INC
DEL MAR AIRPORT
DEL MAR CALIFORNIA

DRAWING NUMBER
11420-400

SHEET 7 OF



NEXT ASSY | USED ON | NEXT ASSY | FINISH
APPLICATION | QTY REQD

UNLESS OTHERWISE SPECIFIED	DRAWN	DATE
DIMENSIONS ARE IN INCHES	R. COLLIER	7-22-60
TOLERANCES ON: FRACT. ± DEC. ± ANGLES ±	CHECKED BY	DATE
	APPROVED BY	DATE
MATERIAL	FINISH	

TITLE: "D" BOARD ASSEMBLY, SCHEMATIC
MODEL V34A & V35A

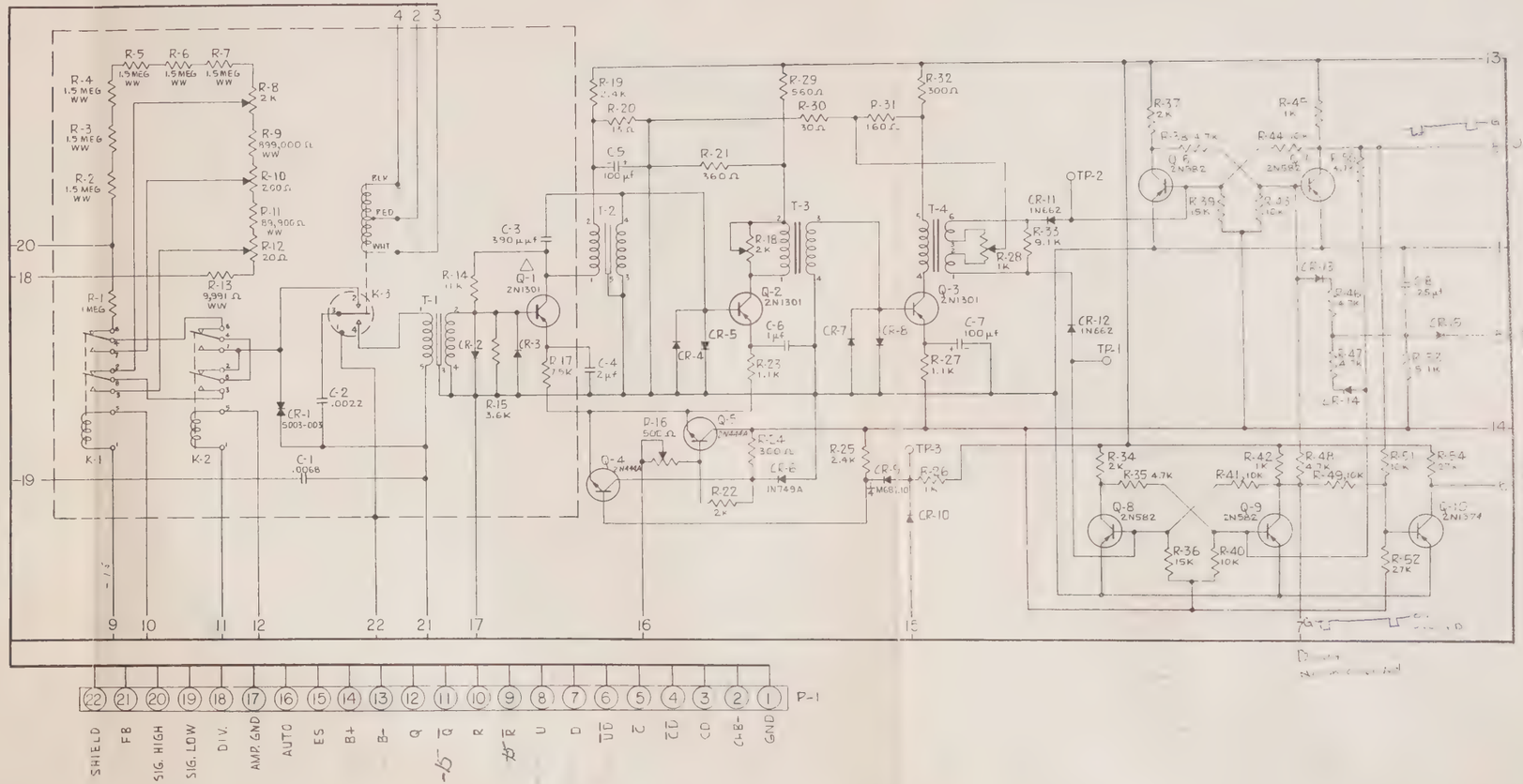
NLS NON-LINEAR SYSTEMS INC.
DEL MAR AIRPORT
DEL MAR, CALIFORNIA

SCALE | WT | DRAWING NUMBER 11420-500 | SHEET 2 OF

1. DIODES ARE NLS NO. 5003-002

NOTES – UNLESS OTHERWISE SPECIFIED:–

REVISIONS				
REV	EFFECT	DESCRIPTION	DATE	APPROVAL
1	ALL	K-1 thru K-3 MFRS changed to Potter & Brumfield. Added type No's Q4, Q5, Q10 was 2N185.	23 Sept 60 ABW	9-23-60 R.K.A.
2	ALL	Added type No's Q4, Q5, Q10 was 2N185.	23 Sept 60 ABW	9-22-60 R.K.A.



11420-E0.0
SHEET 2
2

⚠ SELECTED FOR LOW NOISE.
3. ALL COMPONENT REF. NUMBERS ARE IN THE 600 SERIES; i.e. P-1 = P-601
2 DIODES ARE TYPE 5003-002.
1. CAPACITOR VALUE IS IN MICROFARADS.
NOTES— UNLESS OTHERWISE SPECIFIED:

NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

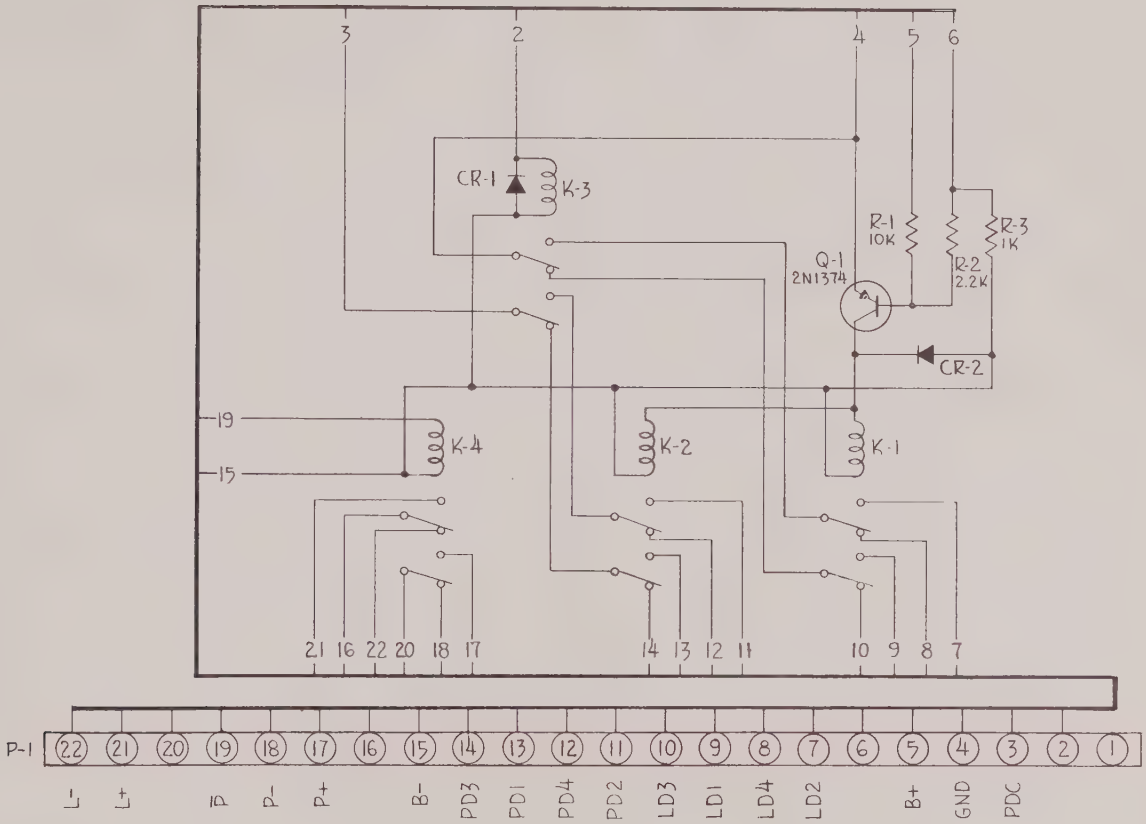
UNLESS OTHERWISE SPECIFIED	DRAWN BY	DATE
DIMENSIONS ARE IN INCHES	A. D. WALLIN	9-26-60
TOLERANCES ON FRACTION / DECIMAL / ANGLES	CHECKED BY	DATE
MATERIAL	APPD. [illegible] BY Clement	DATE 9-30-60
	FINISH	

TITLE
SCHEMATIC—
AMPLIFIER BD. ASSEM.
V34A V39A
DIGITAL VOLTMETER

NON-LINEAR SYSTEMS INC.
DEL MAR AIRPORT
DEL MAR, CALIFORNIA

DRAWING NUMBER
11420-600

SCALE — WT — SHEET 2 OF

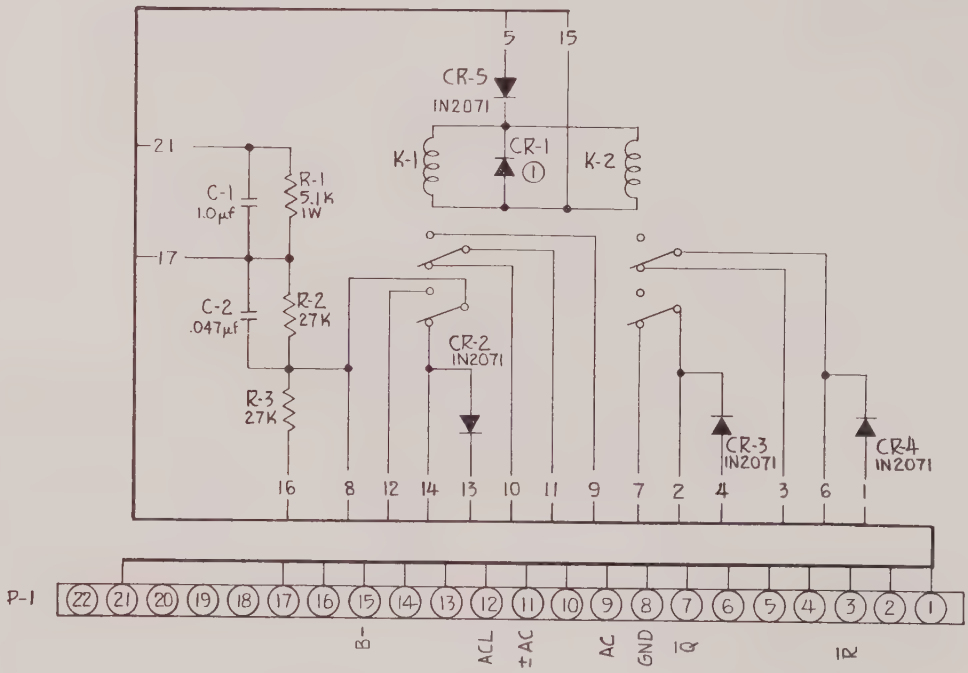


2. COMPONENT REF. NO'S ARE IN 800 SERIES-i.e. R-3 = R-803
1. DIODES ARE NLS NO 5003-002

NOTES - UNLESS OTHERWISE SPECIFIED:-

NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTION DECIMAL ANGLES ± ± ° MATERIAL	DRAWN BY A. R. WALLIN DATE 9 JUNE '60 CHECKED BY R. L. Hoelzner DATE 6-9-60 APPROVED BY R. L. Hoelzner DATE 6-22-60 FINISH	TITLE SCHEMATIC— 4 RELAY BOARD ASSEMBLY V34A V35A DIGITAL VOLTMETER SCALE WT.	NLS NON-LINEAR SYSTEMS INC. DEL MAR AIRPORT DEL MAR, CALIFORNIA DRAWING NUMBER 11420-800 SHEET 2 OF



2. COMPONENT REF. NO'S ARE IN 830 SERIES i.e. CR-4 = CR-834

① NLS NO. 5003-002 DIODE

NOTES - UNLESS OTHERWISE SPECIFIED:-

NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED	DRAWN BY	DATE
DIMENSIONS ARE IN INCHES	A. K. WALLIN	9 DEC '60
TOLERANCES ON FRACTION ± DECIMAL ± ANGLES ±	CHECKED BY	DATE
	APPROVED BY	DATE
MATERIAL	FINISH	

TITLE

SCHEMATIC

2 RELAY BOARD ASSEMBLY

V34A V35A

DIGITAL VOLTMETER

NON-LINEAR SYSTEMS INC.

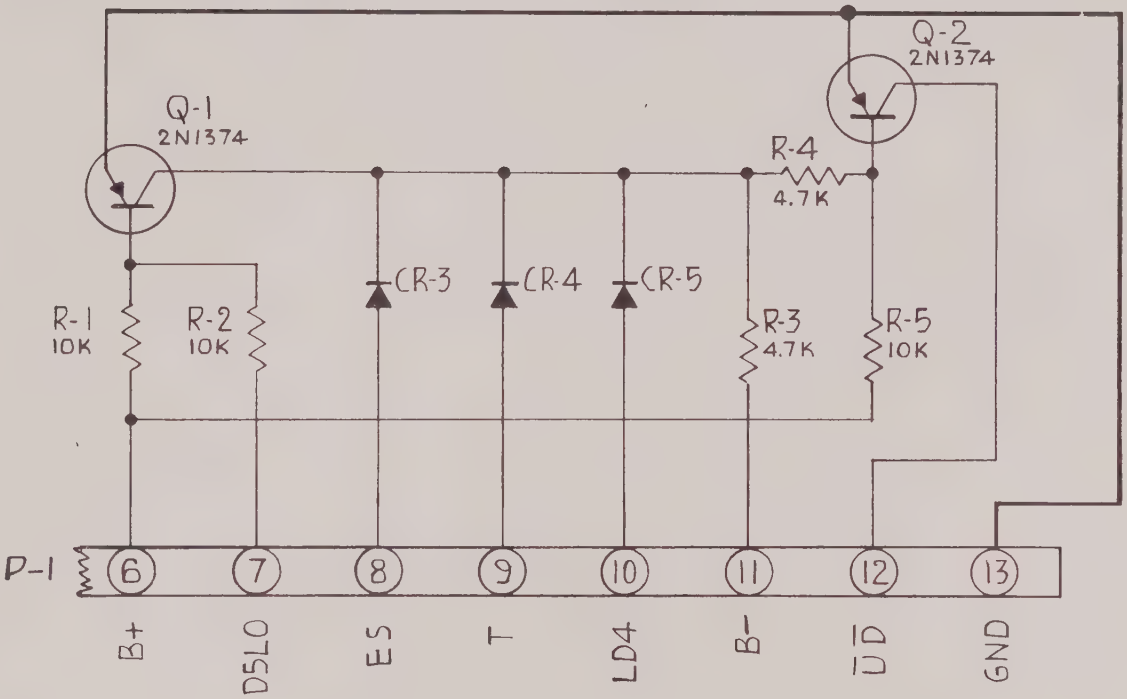
DEL MAR AIRPORT

DEL MAR, CALIFORNIA

DRAWING NUMBER 11420-830

SCALE | WT

SHEET 2 OF



2. COMPONENT REF. NO'S ARE IN 86D SERIES—
   i.e. R-2 = R-862
1. DIODES ARE NLS NO. 5003-002.

NOTES—UNLESS OTHERWISE SPECIFIED:

NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

DRAWN BY A.R. WALLIN	DATE 9-2-60
CHECKED BY [illegible]	DATE 9-6-60
APPROVED BY [illegible]	DATE 9-6-60
FINISH	

TITLE

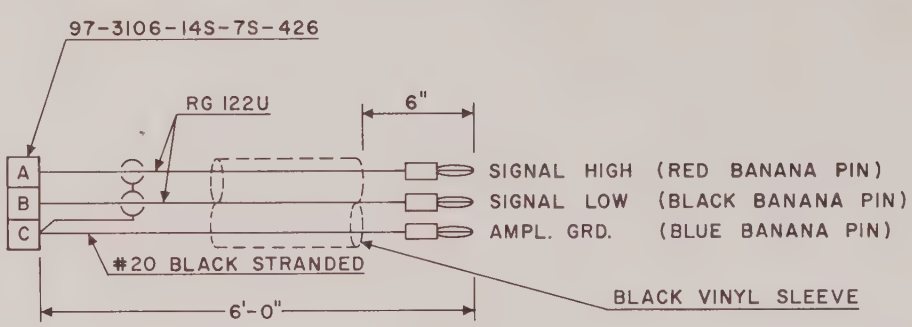
SCHEMATIC—
DECIMAL CHECK BOARD ASSEMBLY
V34A V35A
DIGITAL VOLTMETER

SCALE | WT.

NON-LINEAR SYSTEMS INC.
DEL MAR AIRPORT
DEL MAR, CALIFORNIA

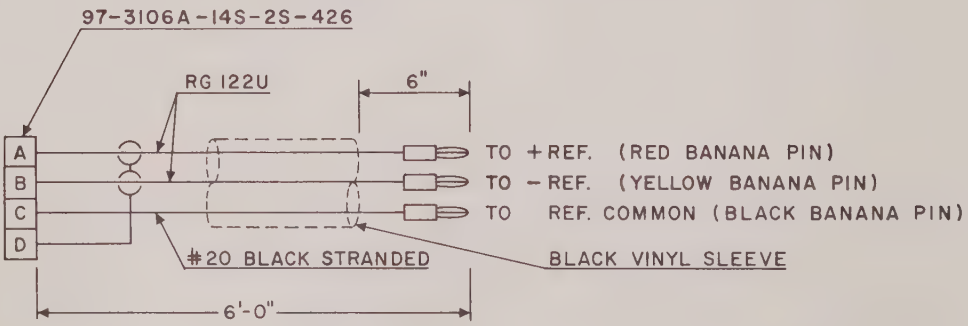
DRAWING NUMBER
11420-860

SHEET 2 OF



QTY.	INCLUDED WITH THIS CABLE
1	#1410-C1 SAFE-T-KLIP
1	#1410-C2 SAFE-T-KLIP
3	#332-A SPADE LUGS, BIRNBACH
1	#31 ALLIGATOR CLIP, BIRNBACH

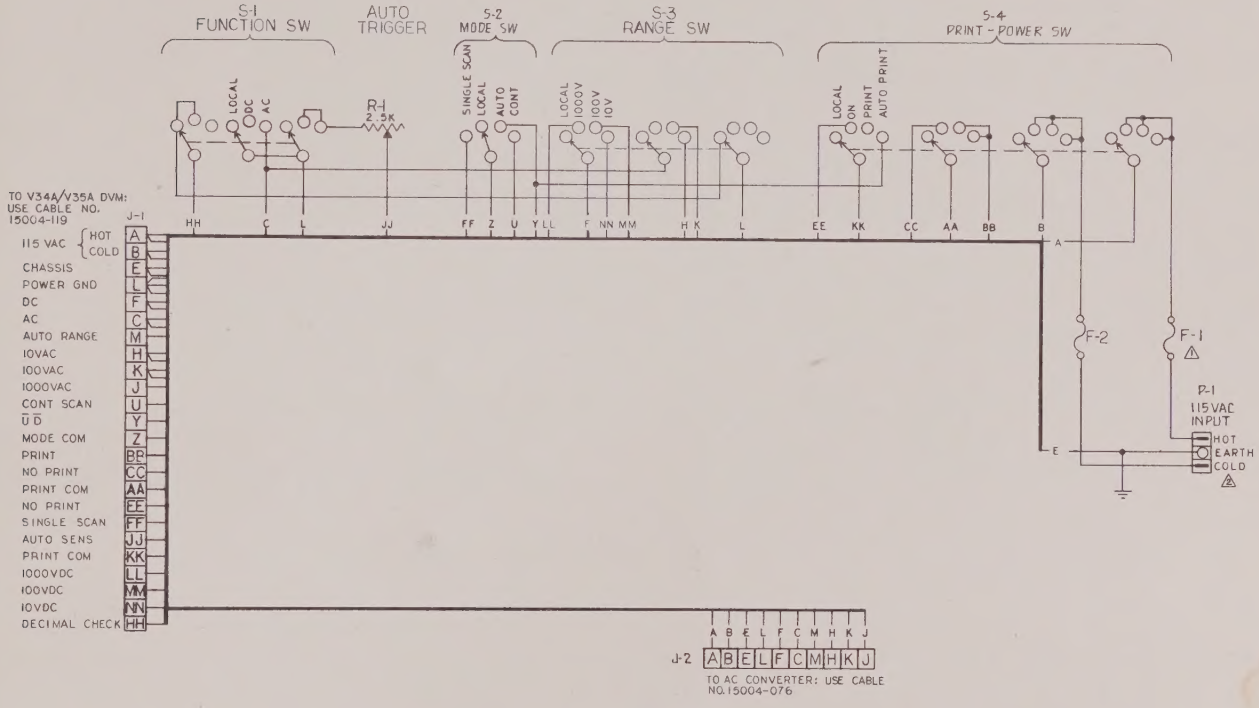
DRAWN BY R. COLLIER	DATE 8-1-60	TITLE	NON-LINEAR SYSTEMS INC.
CHECKED BY R.L.H	DATE 8-1-60	CABLE, INPUT	DEL MAR AIRPORT DEL MAR, CALIFORNIA
APPROVED BY R. Hoover	DATE 8-1-60		DRAWING NUMBER 15004-126
FINISH		SCALE / WT.	SHEET OF



QTY.	INCLUDED WITH THIS CABLE
2	#1410-C1 SAFE-T-KLIP
1	#1410-C2 SAFE-T-KLIP
3	#332-A SPADE LUGS, BIRNBACH

DRAWN BY R. COLLIER	DATE 8-1-60	TITLE	NON-LINEAR SYSTEMS INC.
CHECKED BY R.L.H.	DATE 8-1-60	CABLE, EXTERNAL REFERENCE	DEL MAR AIRPORT DEL MAR, CALIFORNIA
APPROVED BY R. Hoover	DATE 8-1-60		DRAWING NUMBER 15004-125
FINISH		SCALE / WT.	SHEET OF

REVISIONS				
SYM.	EFFECT.	DESCRIPTION	DATE	APPROVAL
1	ALL	S-1 AA WAS DD	13 JULY 69	9-30-69
2	ALL	Added Decimal Check Circuitry	26 SEPT 69	10-3-69



7. THIS UNIT IS AN ACCESSORY, NOT A PART OF THE V34A/V35A; THIS DWG. IS INCLUDED WITH THE V34A/V35A DWGS. FOR REFERENCE ONLY.
6. PRIOR TO SERIAL NO. 11.3574, IF REMOTE CONTROL IS DESIRED, A WIRE FROM PIN HH OF J116 TO PIN 3 OF J121 AND WIRING TO PINS 4, 5 & 13 MUST BE ADDED PER DWG. NO. 11520-100 / 11420-100 CHG 3; ALL V34A/V35A FOLLOW INSTRUCTIONS PER NOTE 6 OF REF. DWG.
5. REMOTE CONTROL OF THE RATIO FUNCTION IS NOT AVAILABLE.
4. FOR REMOTE CONTROL THE DVM SWITCHES MUST BE SET AS FOLLOWS: FUNCTION TO "DC", MODE TO "STANDBY", AUTO TRIGGER TO "MAX", RANGE TO "AUTO", AND POWER TO "OFF."
3. FOR LOCAL CONTROL AT THE DVM, S-1 THRU S-4 MUST BE SET TO LOCAL.
2. PLUG POLARIZATION MUST BE OBSERVED.
1. FOR REMOTE CONTROL OF V34A/V35A, USE 3AG 1A SLOW BLOW FUSE; FOR REMOTE CONTROL OF V34A/V35A AND THE 125 C OR 125E CONVERTER, USE 3AG 1 1/2 A SLOW BLOW FUSE.

NOTES - UNLESS OTHERWISE SPECIFIED: —

	11420			
NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY	
APPLICATION		QTY REQD		

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES; TOLERANCES ON FRACTION, DECIMAL, ANGLES	DRAWN BY: NEW — DATE: 6-29-66	TITLE: SCHEMATIC - REMOTE CONTROL	NLS NON-LINEAR SYSTEMS INC. DEL MAR AIRPORT DEL MAR, CALIFORNIA
MATERIAL	CHECKED BY: R.L. HAFLICHER — DATE: 6-29-66	V34A, V35A	DRAWING NUMBER: 15057
	APPROVED BY: M.C. Clement — DATE: 6-30-66		
	FINISH	SCALE — WT.	SHEET 2 OF

non linear
systems, inc.
DEL MAR, CALIFORNIA

www.manualsplus.com
1022576